

Mackenzie Mountain
Non-resident and Non-resident
Alien Hunter Harvest Summary
2014

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Environment and Natural Resources
Government of the Northwest Territories

2015

Manuscript Report No. 250

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ABSTRACT

Each of the eight licenced outfitters and Renewable Resource Officers with the Sahtú and Dehcho Environment and Natural Resources (ENR) regional offices collected data on big game harvested in the Mackenzie Mountains during the 2014 hunting season. Harvest data and observations of wildlife from non-resident and non-resident alien hunters (collectively called 'non-resident' for this report) were recorded. For 2014, 402 hunters bought non-resident licences, which is higher than the average 369 (range 321-407) sold to non-resident hunters from 1991-2014, but similar to sales over the past ten years. Hunters (n=305) from outside Canada (non-resident aliens) were primarily from the USA (n=259) and comprised 64% of the outfitted hunters; 20 and eight hunters were from Germany and Mexico respectively, with four hunters coming from Australia. There were 97 (24%) Canadian hunters, whose residency was from outside the Northwest Territories (NWT); of these, 83 were from Alberta or British Columbia. Of the 402 non-resident licence holders, 351 came to the NWT and most spent at least some time hunting.

Two hundred and sixty-four tags were purchased for Dall's sheep; 208 rams were harvested (including four by resident hunters). The average annual ram harvest over the past 24 years was 198. The mean ($\pm$ SD) age of harvested rams was 10.5 ± 1.7 years; the fourth highest average age since records have been kept (1967), and the 27th consecutive year the average age of harvested rams from the Mackenzie Mountains has been ≥ 9.5 years. The average right horn length was 88.4 cm with the percent of broomed horns considerably lower than average. Hunters reported seeing fewer legal rams (horns at least $\frac{3}{4}$ curl) than rams with horns $< \frac{3}{4}$ curl during their hunts, average seven legal rams/hunt. Based upon hunter observations we estimated 55.2 lambs and 92.7 rams per 100 ewes, respectively. In 2014, 327 tags were purchased for

northern mountain caribou, the greatest number since reporting started in 1991. The harvest of 179 bull caribou was higher than the average of 160 (range 117-191) from the past 24 years. Hunters observed an estimated 36.0 caribou calves and 41.0 bulls per 100 adult female caribou, respectively.

One hundred and twenty-three tags were purchased for moose this year, the second highest since reporting started in 1991. The harvest of 69 bull moose was above the 24 year average of 57 since 1991, but lower than the previous four years. Hunters observed an estimated 29.5 moose calves and 103.2 bulls per 100 adult female moose, respectively. From 2004-2012, the cow:calf ratio was $\geq 30:100$. Teeth from 130 moose have voluntarily been provided for aging; the age range is 3-15 years (mean 7.6; median 7.0).

This year 57 tags were purchased for mountain goats; the second highest number of tags purchased and considerably greater than the average 46 tags purchased for last 10 years. Fourteen goats (thirteen males, one female) were harvested; mean age determined by horn annuli, was 8.0 years (range 3.5-16.5 years). The 16.5 year old harvested this year is the oldest recorded. Hunters observed an estimated 67.8 goat kids and 58.5 billies per 100 adult nannies.

Regarding carnivores: twenty-three wolves were harvested from 298 tags purchased, including two harvested during the winter season in zone S/OT/01. The harvest of 23 wolves in 2014 is somewhat higher than the annual average of 15 since reporting started in 1991. Hunters observed 275 wolves in 2014 (range 142-317 observed annually 1995-2013). One wolverine was harvested from 154 tags purchased in 2014. Hunters observed 28 wolverines in total including three pairs. Wolverines were observed in all eight zones this year. Only once has this happened before, in 1997. No black bears were harvested from 19 tags purchased. Only five

black bears have been harvested in the Mackenzie Mountains since 1991. This year black bears were observed north of 64°N latitude. There has been no grizzly bear hunting season for non-residents since 1982. Hunters observed more grizzly bear adults and cubs than 1996 when observations were first recorded. Three nuisance grizzly bears were killed in 2014. This year a hunter was fatally mauled by a grizzly bear; the first human fatality since non-resident grizzly bear hunting was closed in 1982.

Hunter satisfaction remains high; 98% of respondents (n=262) rated their experience as either excellent (88%) or very good (10%). The high quality hunting experience, the abundance of wildlife in the Mackenzie Mountains (both game and predators), and the impressive management and stewardship of the land were specifically commented on. Repeat clients (24% of respondents) had returned for a 2nd to 20th hunt, and 92% of respondents indicated they would like to return in future years. We received 75% of the voluntary hunter observation forms, the second greatest return since 1995 when we initiated observation forms. This is an encouraging sign after five consecutive years of approximately 60% return. The new reporting system we designed with the Association of Mackenzie Mountain Outfitters for summarizing wild game meat records continues to work extremely well. This is the fourth year in a row we have been able to summarize information about meat distribution for all eight outfitters. We estimated a minimum of 20,104 kg (44,229 lbs.) of wild game meat, mostly moose and mountain caribou, was distributed locally this year. Replacement cost of meat from local northern retailers is conservatively estimated at \$502,600 using \$25/kg average replacement cost. Although the boundaries of Nahanni National Park Reserve were substantially expanded in 2009, affecting outfitting zones D/OT/01, D/OT/02, and S/OT/03, until negotiations between these outfitters and Parks Canada are completed, the Department of Environment and Natural Resources will

continue to issue licences, tags, and export permits^v for harvesting big game by these three outfitters in their zones.

The prevalence of *Trichinella* spp. in wolves from the Mackenzie Mountains (89%) is higher than that found in wolves from elsewhere in the Dehcho. No *Trichinella* spp. was detected in the 121 samples from cohabiting large mammal prey species.

From 2010-2013 kidney and muscle tissues were collected opportunistically from Dall's sheep, mountain caribou, moose, and mountain goat. Samples were analyzed for 33 stable elements and radionuclides. Renal cadmium was highest in moose and lowest in Dall's sheep. Renal mercury was highest in caribou and lowest in moose. ¹³⁴Cesium was detected in muscle tissue of two Dall's sheep and three mountain goats sampled in 2011. This is a clear marker of deposition from the Fukushima reactor accident.

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INTRODUCTION

General Background

The 140,000 km² (54,000 mi²; 34.6 million acres) area of the Mackenzie Mountains in the western Northwest Territories (NWT) was first opened to non-subsistence hunters in 1965 (Simmons 1968). Since then, the Mackenzie Mountains have become world-renowned for providing a high quality wilderness hunting experience (Veitch and Simmons 1999, www.huntingreport.com, www.spectacularnwt.com/whattodo/hunting/themackenziemountains), particularly for Dall's sheep and more recently moose. In return, non-resident hunters and outfitters in the Mackenzie Mountains provide about \$2.5 million annually to individuals, businesses, and governments in the NWT (Harold Grinde personal communication). The outfitted hunting industry in the Mackenzie Mountains also provides employment for 150-170 outfitters, guides, pilots, camp cooks, camp helpers, and horse wranglers (Werner Aschbacher personal communication). In addition, fresh meat from many harvested animals is provided to a number of local communities including Tulit'a, Fort Good Hope, and Norman Wells in the Sahtú and Wrigley, Nahanni Butte, Fort Liard and Fort Simpson in the Dehcho. This meat is distributed among local elders and residents and to health/long term care facilities. The estimated annual replacement value of this meat has ranged from *ca.* \$60,000-\$625,000.

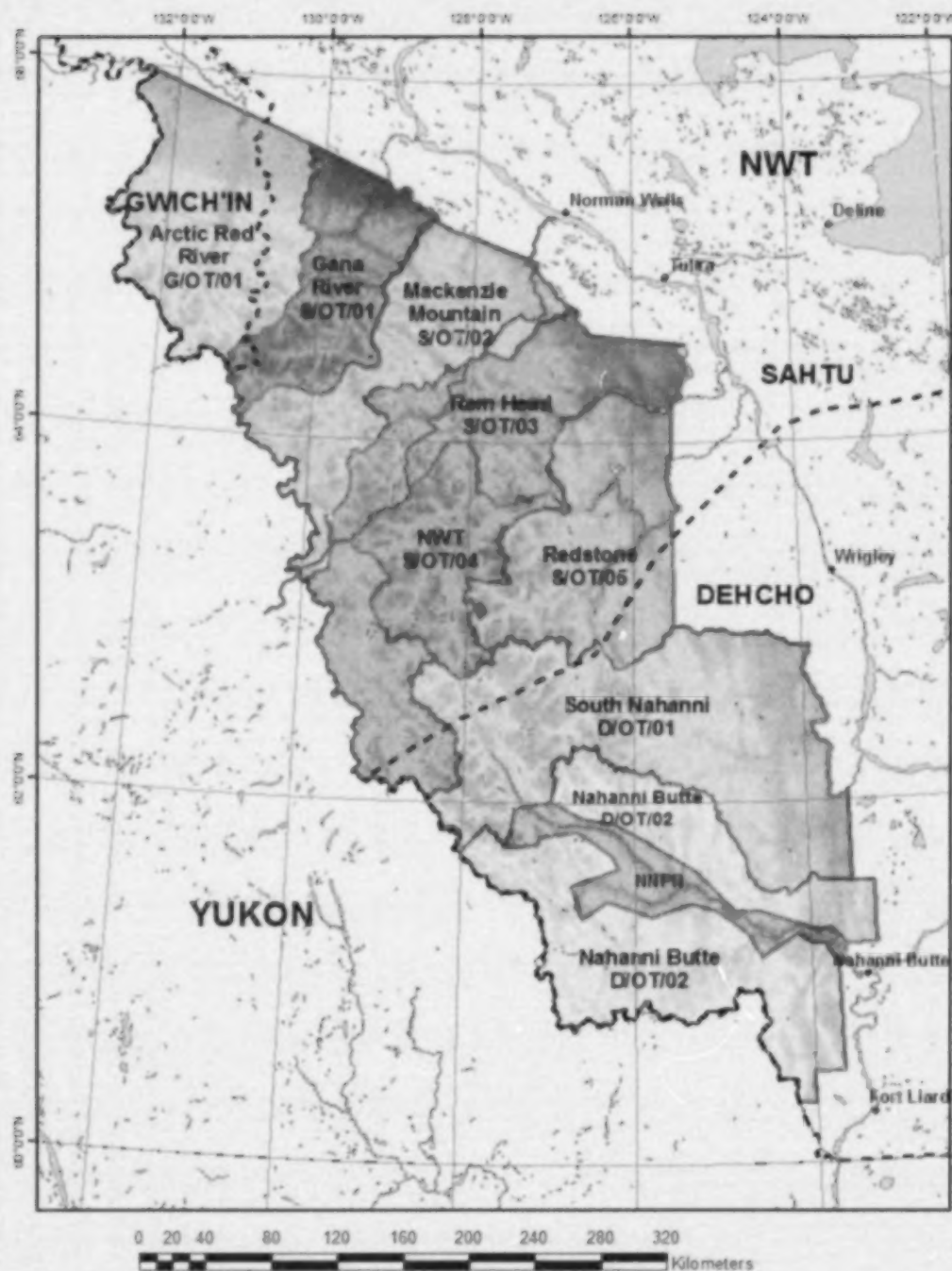
Eight outfitters are currently licenced by the Government of the Northwest Territories (GNWT) to provide big game outfitting services within the Mackenzie Mountains (Figure 1, Appendix A). No hunting is permitted within the original boundaries of Nahanni National Park Reserve (NNPR) (Figures 1, 2) except for subsistence harvest by NWT General Hunting Licence (GHL) holders. Under the NWT *Wildlife Act*, each licenced outfitter has the exclusive privilege

of providing services within their zone, which enhances the outfitters' ability to practice sustainable harvest through annual allocation of the harvest effort.

The hunting licence year in the NWT runs from 01 July - 30 June and those who desire to hunt big game within the NWT must annually obtain a big game hunting licence and must be at least 12 years old (Environment and Natural Resources 2014a). Any youth under the age of 18 must have the consent of a parent or guardian to obtain a licence. There are four classes of licenced big game hunters in the NWT:

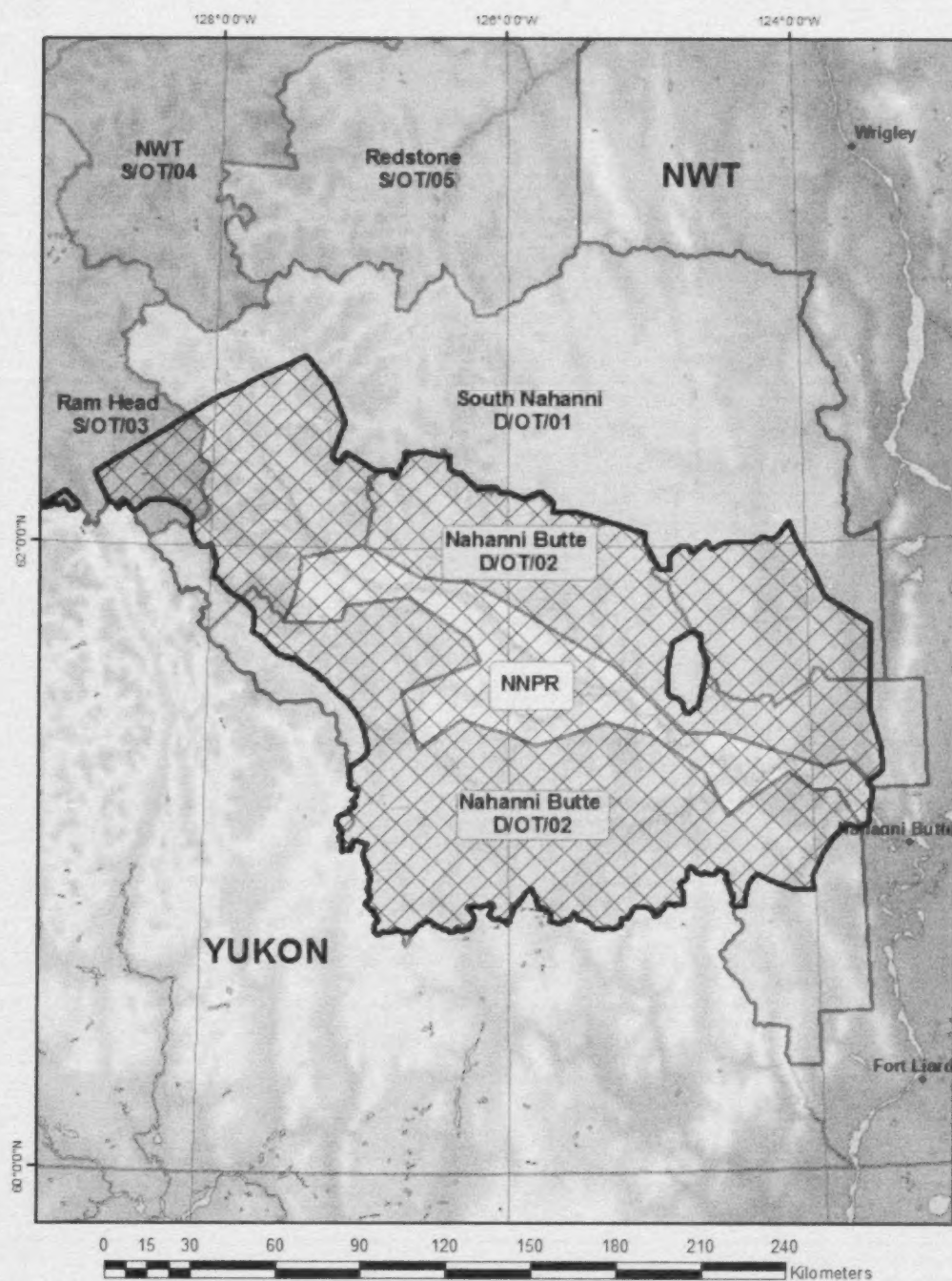
- 1) *General*: subsistence harvesters, primarily Aboriginal people.
- 2) *NWT Resident*: Canadian citizens or landed immigrants who have been living in the NWT for at least 12 continuous months prior to application for the licence.
- 3) *Non-resident*: Canadian citizens or landed immigrants who live outside the NWT, or have not resided in the NWT for 12 months prior to application for the licence.
- 4) *Non-resident Alien*: an individual who is neither a NWT resident nor a non-resident.

Both non-resident and non-resident alien hunters must use the services of an outfitter and must be accompanied by a licenced guide at all times while hunting big game. For simplification in this report, we call both non-resident and non-resident alien hunting licence holders 'non-residents' and combine their harvest statistics. The data from four resident hunters, who harvested Dall's sheep in the Mackenzie Mountains without a guide, have been included in the number of sheep harvested and the age and horn length measurements in this report as indicated.



Scale 1:3,000,000 Projection: Transverse Mercator Datum: NAD 83 THIS IS NOT A LEGAL DOCUMENT

Figure 1: Outfitting zones and land claim areas (dotted lines) of the Mackenzie Mountains, NWT, with Nahanni National Park Reserve (NNPR) original boundary, prior to 2009 expansion, indicated.



Scale 1:1,750,000 Projection: Transverse Mercator Datum: NAD 83 THIS IS NOT A LEGAL DOCUMENT

Figure 2: The original area of NNPR, in white, with the expanded boundary (9 June 2009) indicated by the checkered polygon.

Individual non-resident hunters are annually restricted to one each of the following big game species (Appendix B): Dall's sheep (male with at least one $\frac{3}{4}$ curl horn), northern mountain woodland caribou (either sex), moose (either sex), mountain goat (either sex), wolf (either sex)¹, wolverine (either sex), and black bear [adult not accompanied by cub(s)]. Although non-resident hunters are allowed to hunt female moose and caribou they prefer to hunt males for their trophy antlers and the harvest is exclusively males. Non-resident hunting for grizzly bears was closed in 1982 as a result of concerns about over-harvest (Miller et al. 1982, Latour and MacLean 1994). There are currently no restrictions on the total number of each big game species that an outfitter can take within the zone for which they are licenced.

Wildlife management within the Mackenzie Mountains is the responsibility of a variety of government agencies and boards set up as a result of comprehensive land claim agreements. The NNPR (4,766 km² original pre-2009 boundary) in the south Mackenzie Mountains is managed by Parks Canada – an agency of the Canadian federal government. Under the terms of the *Sahtú Dene and Métis Comprehensive Land Claim Agreement* (signed in 1993) and the *Gwich'in Comprehensive Land Claim Agreement* (signed in 1992), the main instrument of wildlife management within the two settlement areas lies with the Sahtú Renewable Resources Board (SRRB) and the Gwich'in Renewable Resources Board (GRRB), respectively. Approximately 68,000 km² of the central and northern Mackenzie Mountains are within the Sahtú Settlement Area and 8,300 km² are within the Gwich'in Settlement Area, which encompass the extreme north end of the range (Figure 1). However, the GNWT maintains ultimate jurisdiction for management of wildlife and wildlife habitat within each of the claim

¹In the Sahtú region, non-resident hunters and non-resident alien hunters are allowed to hunt two wolves from 1 August - 15 April in S/MX/01. Only one wolf can be hunted in the Dehcho and Gwich'in areas.

areas. The Department of Environment and Natural Resources (ENR) is responsible for licencing outfitters, guides, and hunters and for annually monitoring non-resident big game harvest in the Mackenzie Mountains.

Each year ENR, under the *Wildlife Act* related provisions in the *Wildlife Business Regulations*, requires outfitters to submit an outfitter return on a client hunter success form for each person that purchased a NWT non-resident big game hunting licence (Figure 3). These are known as outfitter return forms and they must be submitted whether or not a client actually hunted, and whether or not any game was harvested. The outfitter return forms allow us to quantify harvest by non-resident hunters to help biologists with the GRRB, SRRB, and ENR to ensure that the harvest of each species is within sustainable limits.

In 1995, the then Department of Resources, Wildlife and Economic Development (RWED), requested that all non-resident hunters also fill out a voluntary questionnaire. The questionnaire has evolved through the years based upon suggestions from outfitters, their clients, and government staff. Different questions pertaining to wildlife observations, the quality of the hunting experience, the quality of services related to hunter travel, and specific topics for hunter comment have come and gone. However, one key component of the questionnaire that has remained constant pertains to reporting the different types and numbers of wildlife species seen during their hunts. These data have been recorded and the questionnaire forms have been referred to as hunter observation forms in this report (Figure 4). These data provide valuable time series of observations and are used in assessing mountain caribou herd status (Larter 2012a).

MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES
HUNTER WILDLIFE OBSERVATION REPORT - 2007

Dear Hunter: The Department of Environment and Natural Resources request your kind assistance with completing this questionnaire about your NWT hunting experience, in order to assist us with the management of Mackenzie Mountain big game populations. All the requested information is completely voluntary, but your providing it to us is most appreciated.

HUNTER INFORMATION

First Name	Last Name		
Address - number and street, box number		Town, City	Province, State, Country

Hunting License # _____ Outfitter Zone: 6107101 Outfitter: ARCTIC RIVER

Start Date of Hunt 7/15 2007 End Date of Hunt 7/24 2007 Observations Made Over 10 Days

ESTIMATED NUMBER OF DALL'S SHEEP SEEN			
Hand and Full Curl Rams	Less than 3/4 Curl Rams	Ewes	Lambs
<u>25</u>	<u>46</u>	<u>24</u>	<u>17</u>

ESTIMATED NUMBER OF WOODLAND CARIBOU SEEN		
Bulls	Cows	Calves
<u>2</u>	<u>1</u>	<u>0</u>

ESTIMATED NUMBER OF MOOSE SEEN		
Bulls	Cows	Calves
<u>0</u>	<u>0</u>	<u>0</u>

ESTIMATED NUMBER OF MOUNTAIN GOAT SEEN			
Billys	Nannys	Kids	Unknown Age
<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>

Other Species						
Number(s) Seen	Wolf	Wolverine	Black Bear		Grizzly Bear	
			Adult	Cub	Adult	Cub
<u>3</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>

How would you rate your overall hunting experience in the Mackenzie Mountains?

Excellent X Very Good _____ Good _____ Fair _____ Poor _____

How many times have you hunted in the Mackenzie Mountains, including this year's hunt? 2

Do you plan to return to hunt in the Mackenzie Mountains again? Yes X No _____

COMMENTS: Excellent Arctic / outfitter

Thank You! Please give this form to the Officer or Clerk when you are exporting your trophies, or to the guide/outfitter with whom you hunted. We would appreciate receiving this form whether or not you harvested an animal(s).

Figure 4: Example of a fully completed hunter observation report form.

This is the twentieth consecutive year that a summary of the data collected by ENR on non-resident hunters in the Mackenzie Mountains has been made. In the text of this document, data for 1995 are found in Veitch and Popko (1996), for 1996 in Veitch and Popko (1997), for 1997 in Veitch and Simmons (1998), for 1998 in Veitch et al. 2000b, for 1999 and 2000 in Veitch and Simmons (2000, 2002, respectively), for 2001 by A. Veitch and N. Simmons (unpublished data), for 2002-2013 in Larter and Allaire (2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 respectively). Additionally, Latour and MacLean (1994) summarized data for 1979-1990. This report compiles the harvest data collected during the 2014 hunting season and compares it with available data collected since 1995, and earlier when available.

Nahanni National Park Reserve Expansion

Nahanni National Park Reserve (NNPR), encompassing an area of 4,766 km² in the southern Mackenzie Mountains, was originally established in 1972, after Prime Minister Pierre Elloit Trudeau canoed down the Nahanni River. The Park was in "reserve" status pending settlement of outstanding Aboriginal land claims in the region, which remain ongoing. On 9 June, 2009, the Canadian government, with Dehcho First Nations, announced legislation increasing the area of NNPR to *ca.* 30,000 km² (11,583 mi²). This newly enlarged boundary includes 91% of the greater Nahanni ecosystem and most of the South Nahanni River watershed in the Dehcho region (www.pc.gc.ca/pn-np/nahanni/ne/ne2-ep.asp).

The enlarged boundary also overlaps three of the eight outfitting zones which were established in the Mackenzie Mountains in 1965: Ram Head Outfitters (S/OT/03), South Nahanni Outfitters (D/OT/01) and Nahanni Butte Outfitters (D/OT/02). Of the total area of their

outfitting zones, 4.7% of the Ram Head zone, 27.2% of the South Nahanni zone and 79.4% of the Nahanni Butte zone fall within the newly expanded boundary of the NNPR (Table 1).

Table 1: The area (km²) and % of the outfitting zone that lie within the 2009 expanded boundary of NNPR.

Outfitter	Area of Outfitting Zone	Area of Outfitting Zone within New NNPR	% of Zone within New NNPR
Ram Head Outfitters	19,734.82 km ²	921.27 km ²	4.7 %
South Nahanni Outfitters	25,024.16 km ²	6,811.10 km ²	27.2 %
Nahanni Butte Outfitters	21,962.30 km ²	17,450.66 km ²	79.4 %

Parks Canada is currently negotiating with the operators of these outfitting zones in regards to third party interests and land transfer. A tentative ten year time line from the date of the announced expanded boundary has been proposed. Until negotiations have been completed, and the GNWT has been advised of such, it remains business as usual for these outfitters; ENR will continue to issue licences, tags, and export permits for harvesting by these three outfitters in their zones.

The Prairie Creek mine, established in 1966, now falls completely within the newly expanded boundary of NNPR. However, the mine and an area of *ca.* 300 km² surrounding the site were specifically excluded from NNPR so that the mine owned by Canadian Zinc was assured of its third party rights to operate and access the mine site. A new bill amending the National Parks Act solely for NNPR was required to assure these third party rights (www.canadianzinc.com).

Change in Ownership of Zone S/OT/02

The 2013 hunting season was the last season for Eric and Lorna Mikkelsen in zone S/OT/02. The zone is now being run by Clay Lancaster. (see Appendix A)

Prevalence of *Trichinella* spp. in Mackenzie Mountain Wildlife

Larter et al. (2011) reported a high prevalence of the parasite *Trichinella* spp. in wolves (52%) and grizzly bears (73%) in the Dehcho. As part of a wildlife disease monitoring program, ENR requested samples of the tongue from harvested animals during 2011-2014 to see if these parasites were also prevalent in prey populations and to document occurrence specifically in the Mackenzie Mountains (Larter and Macdonald 2015). Larter and Allaire (2014) reported the preliminary results of *Trichinella* spp. for testing of Dall's sheep, northern mountain caribou, moose, mountain goat, and wolves. We report the final results from all samples collected from Dall's sheep, northern mountain caribou, moose, and mountain goat during 2011-2014. Sampling and analysis of wolf tongues remains ongoing on a regional basis.

Cadmium and Other Elements in the Tissues of Big Game in the Southern Mackenzie Mountains

Elevated levels of cadmium in the kidneys of moose harvested in the southern Mackenzie Mountains in the NWT and adjacent parts of the Yukon (YT) were reported in the 2000s (Gamberg et al. 2005, Larter 2009). The NWT data led to the release of a public health advisory on consumption of moose kidneys (Larter and Kandola 2010). In 2010, ENR initiated a study to document levels of cadmium and other stable elements and radionuclides in moose, mountain caribou, Dall's sheep, and mountain goats in the southern Mackenzie Mountains.

METHODS

General Background

Prior to the start of the 2014 hunting season, each outfitter in the Mackenzie Mountains received sufficient copies of the outfitter return and hunter observation forms for all their clients for the year. The *Wildlife Business Regulations* requires outfitter return forms to be returned by the tenth day of the month following the month of the hunt – e.g. for a hunter that was in the field in July, a form must be submitted by the 10th of August. Those forms were submitted to the senior biologist in the Dehcho or Sahtú region, whether or not a client actually hunted and whether or not harvest occurred. In co-operation with ENR Renewable Resource Officers and the outfitters, persistent attempts were made to obtain outfitter return forms for every non-resident that held a big game hunting licence through a Mackenzie Mountain outfitter in 2014.

Data from both the outfitter return forms and hunter observation forms were entered into Microsoft Excel (Microsoft Corporation 2010) spreadsheets. Data were cross-checked with the records of sequentially numbered, unique identifier plugs inserted in the horns of legally harvested rams found in the Licence Information System-IntraNet (LISIN) data management system maintained by ENR offices across the NWT, and also with GNWT wildlife export permit forms, to ensure that all data were verified and the spreadsheets contained all appropriate available data required for analyses.

We distributed new hunter observation forms in 2014 for consistency and recorded all observations directly from these hunter observation forms. If we did not receive a hunter observation form, but wildlife observation data were recorded on the outfitter return form, we used these wildlife observation data. If observation information differed between the hunter observation form and the outfitter return form for the same client, we used the data from the hunter observation

form. Occasionally we received identical observation data from forms of different hunters. These hunters had the same guides and lengths of hunts, and obviously had hunted together. We recorded forms with data that had been provided, but for the wildlife observation analyses only one set of observations was used.

All descriptive statistical analyses were performed using Microsoft Excel. We present means $\pm$ standard deviation (SD). Some additional statistical analyses were performed using Minitab 7.2 software (Minitab Inc. 1989).

Prevalence of *Trichinella* spp. in Mackenzie Mountain Wildlife

When the opportunity arose outfitters/guides collected tongue samples, keeping them chilled or frozen until they could be transferred to the regional ENR office. Samples collected in 2011 were forwarded to the Centre for Food-borne and Animal Parasitology, Canadian Food Inspection Agency, Saskatoon for analysis. Samples collected in 2012-2104 were forwarded to the Veterinary Pathology Lab at the Western College of Veterinary Medicine, Saskatoon, for analysis. All samples shipped frozen.

Frozen tongue samples were thawed to room temperature and trimmed to remove fat and connective tissue. The digestion assay for the detection of *Trichinella* spp. larvae in muscle tissue followed Forbes and Gajadhar (1999) and Forbes et al. (2008). Weights of tested tongue varied both within and between species: from 5.0-48.7g for Dall's sheep (n=33), 5.5-29.3g for northern mountain caribou (n=34), 10.0-289.9g for moose (n=39), and 5.0-25.2g for wolves (n=18). Because it is rare to find *Trichinella* spp. in large ungulates, the digestion assay consisted of 2-5 individual samples pooled (Brent Wagner, personal communication). Positive results were converted to larva/g (LPG) of muscle tested.

This report documents the final results from all samples collected from these species during 2011-2014.

Cadmium and Other Elements in the Tissues of Big Game in the Southern Mackenzie Mountains

Kidney and muscle tissue samples (n=173) were collected opportunistically by outfitters and their guides from Dall's sheep, mountain caribou, moose, and mountain goat hunts during the 2010-2013 hunting seasons. Most samples came from zones D/OT/01 and D/OT/02, but additional samples also came from zones S/OT/01 and S/OT/05. A first incisor tooth was collected from moose and mountain caribou and forwarded to Matson's Laboratory (Matson 1981) for aging. The ages of Dall's sheep and mountain goat were determined by counting horn annuli. A multi-element analysis was conducted on frozen kidney and muscle tissues, with the concentrations of 33 elements, including cadmium and mercury. Frozen muscle tissues were also analyzed for their radionuclide content, including ^{134}Cs (^{134}Cs). The detailed methodology for the multi-element and radionuclide analyses and the complete results for all analyses of all samples can be found in Larter et al. (submitted). Some of the key findings are reported here.

RESULTS AND DISCUSSION

Hunters

Big game hunting licences for the Mackenzie Mountains were bought by 402 non-resident hunters in 2014 (Table 2). This is greater than the annual average of 369 licences sold between 1991-2014 (range 321-407), but similar to licence sales over the past 10 years (Figure 5, Appendix F). Of those 402 hunters, 351 came to the NWT and spent some time hunting. The remaining 51 either cancelled their hunts, decided not to hunt for themselves but participated with other hunters they knew, or decided not to hunt due to unforeseen complications after arriving in the NWT. Eight of these 51 were guides. Guides often purchase licences every year but rarely have the opportunity to hunt themselves.

In 2014, licence sales to non-resident Canadians ($n=97$) and residents of countries other than the United States ($n=46$) represented 24% and 11%, respectively, of the number of licences sold (Table 2, Figure 6). The percentage of hunters from the United States has decreased to 60-65% annually since 2005. Conversely, the percentage of hunters from elsewhere in the Americas and Europe has increased. The change in ownership of South Nahanni Outfitters (D/OT/01) directly resulted in an increased number of European and South American clients. We presume the continued strength of the Canadian dollar is a factor in this change. Guided hunts are marketed in American dollars. A weaker American dollar against foreign currencies makes hunts more attractive to foreign clients, and outfitters realize the need to diversify their clientele base (Jim Lancaster personal communication).

Table 2: Province, state and/or country of origin of the 402 non-residents who purchased licences for hunting in the Mackenzie Mountains, 2014.

Canada		United States		W. Europe		Other	
Yukon	4	Eastern States ¹	107	Germany	20	Mexico	8
British Columbia	28	Western States ²	152	Spain	1	Russia	1
Alberta	55			Italy	2	Lebanon	1
Saskatchewan	5			Austria	1	Australia	4
Manitoba	1			France	1	Philippines	1
Ontario/Quebec	4			Norway	1	Hungary	1
				Denmark	1	Poland	1
				Switzerland	1	New Zealand	1
Total	97		259		28		18

¹AL, AR, CT, DE, FL, GA, IL, IN, IA, KY, LA, ME, MD, MA, MI, MN, MS, MO, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV, WI

²AK, AZ, CA, CO, HI, ID, KS, MT, NE, NV, NM, ND, OK, OR, SD, TX, UT, WA, WY

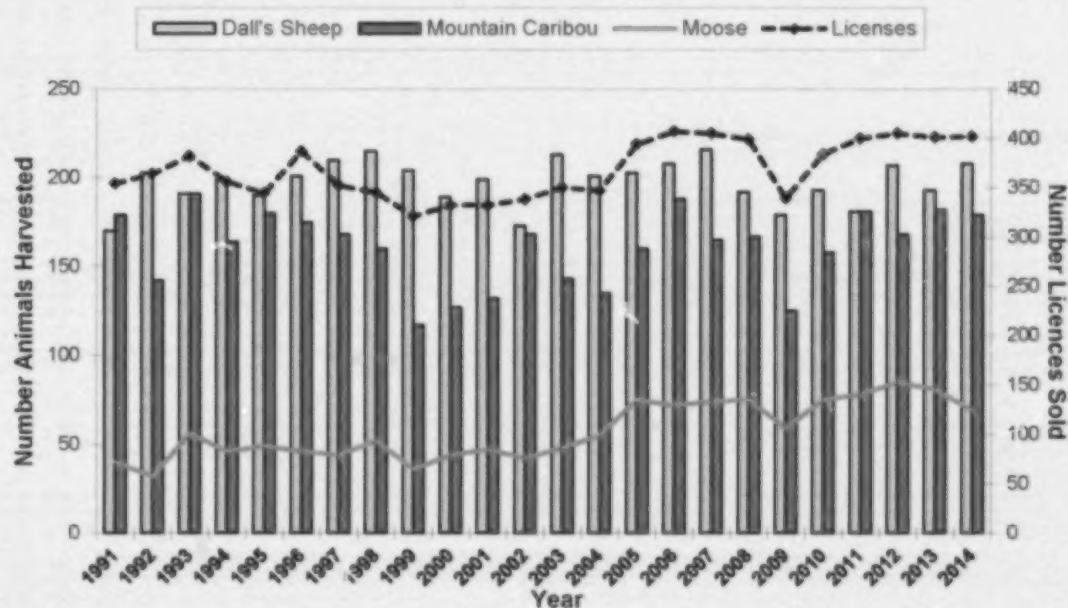


Figure 5: The number of Dall's sheep, mountain caribou, and moose harvested in the Mackenzie Mountains by non-resident hunters, and the number of non-resident licences sold during 1991-2014.

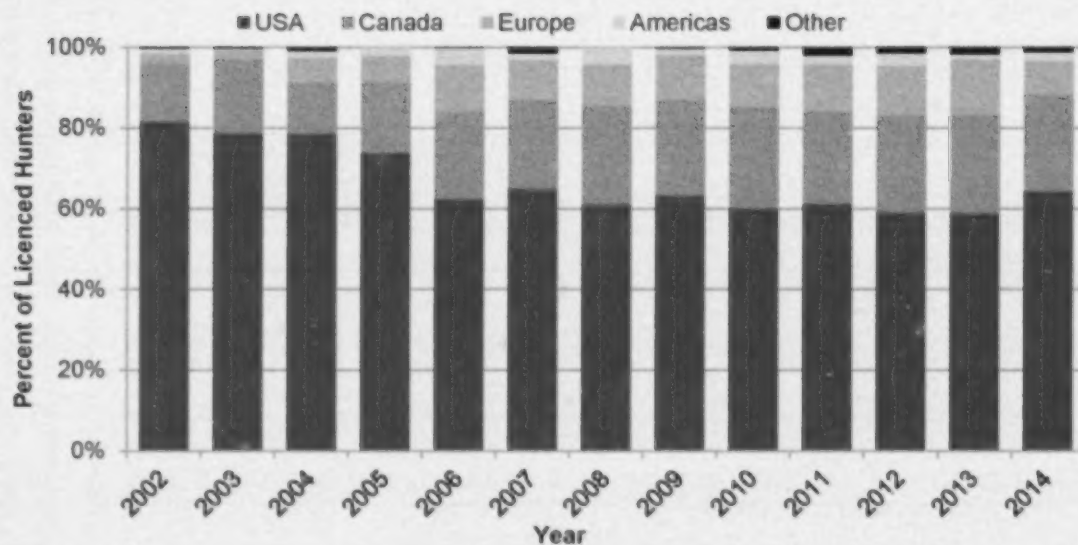


Figure 6: The geographical areas of origin of hunters purchasing licences (in %) to hunt in the Mackenzie Mountains from 2002-2014.

Normally, guided hunting in the Mackenzie Mountains occurs from July to October, however successful winter hunting of wolves occurred for the sixth consecutive year in zone S/OT/01. Two wolves were harvested in spring 2015.

We received all but four mandatory outfitter return forms for the 402 people that purchased non-resident licences. We received 262 (75%) of the possible 351 voluntary hunter observation forms from hunters in 2014 (Table 3). This is the second highest return since we initiated voluntary reporting in 1995, and an encouraging sign after five consecutive years of approximately 60% return despite consensus at previous Association of Mackenzie Mountain Outfitters (AMMO) general meetings to increase the return of voluntary hunter observation forms. Some of the increase may be attributed to a change in ownership of S/OT/04 for the 2014 hunting season. This year the majority of hunters from this zone returned hunter observation forms which was not the norm previously. Although most outfitters endeavour to have clients complete and submit these forms, we received only 55% of the 74 forms from G/OT/01, 57% of

the 68 forms from S/OT/02, and 19% of the 31 forms from S/OT/03. The limited returns from outfitting zones with fairly large clientele remains a concern because in order to generalize observations over the entire Mackenzie Mountains, representative observations are required from all outfitting zones; two of these outfitter zones with poor return of forms encompass the greatest range in latitude in the Mackenzie Mountains (Figure 1). See Figure 4 as an example of a fully completed hunter observation form.

Table 3: Percent of Mackenzie Mountain outfitter and non-resident hunter forms submitted, 1995-2014.

Form Type	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
Outfitter Return (mandatory)	99	98	99	99	98	99	99	98	99	100
Hunter Observation (voluntary)	75	56 ¹	60	62	60	62	71	65	64	65

¹5% of forms were lost after being completed but prior to submission.

Form Type	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Outfitter Return (mandatory)	99	98	95	92	96	96	97	98	100	98
Hunter Observation (voluntary)	74	60	59	57	53	51	60	50	71	80

It is obvious that non-resident hunters immensely enjoy their hunting experience in the Mackenzie Mountains (Table 4). In 2014, 98% of respondents rated their experience as either excellent (88%) or very good (10%). Not only do voluntary client comments make specific mention of the high quality of hunts (n=103), and the abundance/quality of animals (n=48; Appendices C, D), many comments make reference to (1) the professional and world class experience with their chosen guides, (2) the abundance of a wide variety of game species and predators, (3) the apparent health and condition of the game animals, (4) the pristine and scenic

environment of the Mackenzie Mountains, and (5) compliments on the management and stewardship of the land.

Table 4: Satisfaction ratings for non-resident hunters (including non-hunting guides) in the Mackenzie Mountains, 1996-2014.

Rating	2014	2013	2012	2011	2010	2009	2008	2007	2006
Number of Hunters Reporting	262	207	212	210	193	191	239	239	230
Excellent (%)	88	86	93	90	88	86	85	81	80
Very Good (%)	10	11	5	6	10	12	10	12	16
Good (%)	2	2	2	4	1	2	4	5	3
Fair (%)	0	1	0	0	1	0	1	2	1
Poor (%)	0	0	0	0	0	0	0	0	0

Rating	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
Number of Hunters Reporting	256	229	191	193	191	158	157	202	144	224
Excellent (%)	90	84	82	82	75	76	73	80	78	77
Very Good (%)	7	10	15	15	16	17	20	17	17	17
Good (%)	2	5	3	3	6	6	5	2	3	2
Fair (%)	1	0	0	0	1	0	1	1	1	3
Poor (%)	0	1	0	0	1	1	2	0	1	1

Comments about grizzly bears have been common since the start of the voluntary hunter observation forms in 1995; their abundance, problems created around camps and kills, and the lack of, and need for, a grizzly hunting season being consistent themes. This year was no different (Appendices C, D). In 2000 we started getting comments about high wolf numbers. Since the year 2000, comments about high wolf numbers have been made every year except 2013. Comments about the expansion of NNPR questioned the need for such a large expansion, especially in an area that had been so respectfully managed on a sustainable basis, as well as lost hunting opportunities. There was a suggestion about making a provision for hunting to continue

in the expanded area given that GHL holders can hunt in the area. We continue to get comments about the expansion of NNPR, five years after the expansion.

It was the first time hunting in the Mackenzie Mountains for 198 of 262 (76%) respondents (including non-hunting guides). The 63 repeat hunters had hunted from 2-20 times previously. Of 266 respondents (including non-hunting guides) 92% indicated they would like to return to the Mackenzie Mountains to hunt in the future.

Prior to the 2009 hunting season ENR worked with AMMO to devise a better system for reporting wild game meat use and distribution. What resulted was a supplementary summary meat record form that ENR provided to each outfitter. The new form could be used by itself or with the AMMO meat forms which were voluntarily submitted to ENR. Unfortunately, in the past, AMMO meat forms from outfitters in the Sahtú did not always get turned in and/or forwarded to the Dehcho ENR office. Some outfitters kept the meat forms for their own records in order to have them available for inspection (Kelly Hougen personal communication). Both forms record the amount of meat (Dall's sheep, northern mountain caribou, moose, and mountain goat) taken from harvested animals and how the meat was used and/or distributed. This year, in addition to the 168 AMMO meat forms submitted, we received summary forms from all eight outfitters. This is the fourth consecutive year we received records of meat distribution from all eight outfitters. ENR will continue to provide supplementary meat forms to all outfitters.

The distribution of wild game meat by outfitters is an important and greatly appreciated local benefit but can often be a topic of heated local debate. Meat is used in outfitter camps by guides and clients, is taken out with clients, and is provided to local communities. We believe that the information from summary meat record forms provides a better overall picture of the amount of wild game meat being distributed by the outfitters. Generally the majority of meat

from harvested Dall's sheep and mountain goats is used in outfitter camps. Nevertheless, at least 1,463 kg (3,218 lbs.) from 201 harvested Dall's sheep and 355 kg (780 lbs.) from 14 harvested mountain goats was distributed locally. Northern mountain caribou and moose meat is also used in outfitter camps, but harvested mountain caribou and moose make up a large portion of the wild game meat that is distributed locally: at least 7,512 kg (16,526 lbs.) from 177 northern mountain caribou and at least 10,775 kg (23,705 lbs.) from 67 moose. If we use a relatively conservative \$25/kg as the replacement cost for meat from local northern retailers, then some \$502,600 of meat was distributed locally in 2014.

Dall's Sheep (*Ovis dalli*)

Dall's sheep is one of the most desired species sought by non-resident hunters in the Mackenzie Mountains. Tags to hunt Dall's sheep were purchased by 264 (66%) non-resident hunters in 2014. This is similar to the average number of tags purchased in the past 20 years (Table 5). At least 79% of sheep tag holders (including four resident hunters) pursued Dall's sheep and harvested 208 rams, more than the average 198 sheep harvested from 1991-2014, and the most since 2007 (Figure 5, Appendix F). The mean ($\pm$ SD) length of a sheep hunt was 3.8 ± 2.9 days, similar to hunt lengths from 1997-2014 (Table 6), but less than the 5.3 day average from 1979-1990 (Latour and MacLean 1994). Outfitted hunts in the Mackenzie Mountains are generally booked for ten days; when hunters fill their sheep tag, any remaining time is typically spent in pursuit of other big game species for which tags are held, or in hunting small game. The number of hunters taking multispecies hunts has increased in recent years (Jim Lancaster personal communication and Werner Aschbacher personal communication).

Table 5: Tags for big game species purchased by non-resident hunters with outfitters in the Mackenzie Mountains, 1995-2014.

Species	2014 402 hunters		2013 401 hunters		2012 396 hunters		2011 400 hunters		2010 384 hunters		2009 339 hunters		2008 391 hunters		2007 399 hunters		2006 407 hunters		2005 394 hunters	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Dall's Sheep	264	66	264	66	270	68	251	63	253	66	215	63	261	67	266	67	276	68	246	62
Mountain Caribou	327	81	296	74	300	76	314	79	295	77	252	74	275	70	272	68	274	67	285	72
Moose	123	31	131	33	115	29	121	30	116	30	96	28	109	28	108	27	112	28	101	26
Mountain Goat	57	14	58	14	42	11	55	14	45	12	45	13	45	12	50	13	21	5	40	10
Wolf	298	74	299	75	292	74	285	71	294	77	252	74	228	58	227	57	201	49	214	51
Wolverine	154	38	155	39	153	39	163	41	171	45	133	39	111	28	150	38	108	27	154	39
Black Bear	19	6	34	8	16	4	32	8	28	7	22	6	2	1	7	2	3	1	40	10

Species	2004 337 hunters		2003 347 hunters		2002 329 hunters		2001 339 hunters		2000 332 hunters		1999 321 hunters		1998 345 hunters		1997 352 hunters		1996 387 hunters		1995 343 hunters	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Dall's Sheep	229	68	257	74	218	66	220	65	231	70	227	71	246	71	252	72	252	65	218	64
Mountain Caribou	243	72	247	71	229	69	201	59	206	62	181	56	223	65	260	74	274	71	233	68
Moose	84	25	85	24	68	21	65	19	69	21	63	20	69	20	73	21	74	18	70	20
Mountain Goat	24	7	18	5	18	5	12	4	12	4	6	2	23	7	30	8	14	4	16	5
Wolf	166	49	207	60	159	48	137	40	155	47	89	28	165	48	209	59	193	50	72	21
Wolverine	89	26	141	40	97	29	83	25	85	26	65	20	99	29	135	38	114	30	35	10
Black Bear	8	2	9	3	3	1	0	0	6	2	2	<1	2	<1	8	2	0	0	0	0

Table 6: Mean length, SD, and range (in days) of Dall's sheep hunts where at least one day was spent hunting from 1997-2014.

	2014	2013	2012	2011	2010	2009	2008	2007	2006
Number of Reports	206	193	207	173	179	179	192	216	214
Mean Hunt Length	3.8	4.0	4.0	4.0	4.0	3.9	3.7	4.1	4.1
SD	2.9	3.0	3.0	3.0	3.0	2.6	2.6	2.6	2.7
Range	1-14	1-13	1-14	1-11	1-13	1-10	1-14	1-13	1-12
	2005	2004	2003	2002	2001	2000	1999	1998	1997
Number of Reports	190	167	189	174	176	198	201	224	216
Mean Hunt Length	4.1	4.0	3.8	4.7	4.8	4.6	4.7	4.4	4.3
SD	2.6	2.9	2.9	2.7	3.0	2.7	3.1	2.8	2.6
Range	1-14	1-17	1-12	1-15	1-15	1-15	1-16	1-15	1-12

Harvest by non-residents comprises at least 90% of the total annual harvest of Dall's sheep in the Mackenzie Mountains and takes only 0.9-1.6% of the estimated 14,000-26,000 Dall's sheep in the Mackenzie Mountains (Veitch et al. 2000a). Therefore, the current non-resident harvest level appears well within sustainable limits, provided that hunting pressure is geographically distributed across each of the zones. In the Yukon (YT) - where harvest is managed by a full curl rule - Dall's sheep managers have set the sustainable harvest at 4% of the non-lamb population (YT Renewable Resources 1996). In those areas of the YT where the management objective is to increase population size, harvest is limited to 2% of the total population.

There has been remarkable consistency in the mean outside contour length of the right horns from rams harvested by non-residents for the past 43 years (1972-2014), mean 89.0 ± 1.6 cm (SD) (Appendix E, Table 7), which is surprising given the increase in average age of harvested sheep during that same period. We expected to see more broomed or broken horn tips

on older animals, since horn breakage generally occurs as a result of fights between rival males (Geist 1993).

Table 7: Measurements of Dall's sheep ram horns from sheep harvested by non-resident hunters in the Mackenzie Mountains, 2014.

	Left Horn Contour Length		Right Horn Contour Length		Left Horn Base Circumference		Right Horn Base Circumference		Tip To Tip Spread	
	cm	in	cm	in	cm	in	cm	in	cm	in
Mean	88.4	34.8	88.4	34.8	32.7	12.9	32.7	12.9	58.0	22.8
SD	8.1	3.2	8.1	3.2	1.9	0.7	1.8	0.7	8.2	3.2
Maximum	105.0	41.3	106.3	41.9	37.0	14.6	37.5	14.8	81.5	32.1
Minimum	59.0	23.2	63.0	24.8	24.0	9.4	24.0	9.4	32.0	12.6

This year we aged 207 of the 208 harvested rams; 125 (60%) were ≥ 10 -years-old. The mean age ($\pm$ SD) of harvested rams was 10.5 ± 1.7 years (range 7.5-14.5 years, Figure 7). This is the fourth highest average age of harvested rams recorded in the Mackenzie Mountains since records have been kept (1967) and the 27th consecutive year where the reported mean age of harvested rams was 9.5 years or older (Appendix E). The percentage of broomed horns, 32% left and 32% right, from plugged trophies this year was similar to the average of 31% left and 32% right over the past 18 years.

The continued high age of harvested trophy sheep may be a result of harvest being spread out in time and space within hunting zones. Exclusivity of non-resident big game harvesting within each zone provides the opportunity for outfitters to harvest in different parts of their zone on a rotational basis and forgo hunting in some areas for two or three seasons. In recent years some outfitters have used helicopters to gain access into areas not accessible by horseback. These areas have not been exposed to hunting previously, and spread out the harvest in space, likely contributing to the continued high average age of harvested rams.

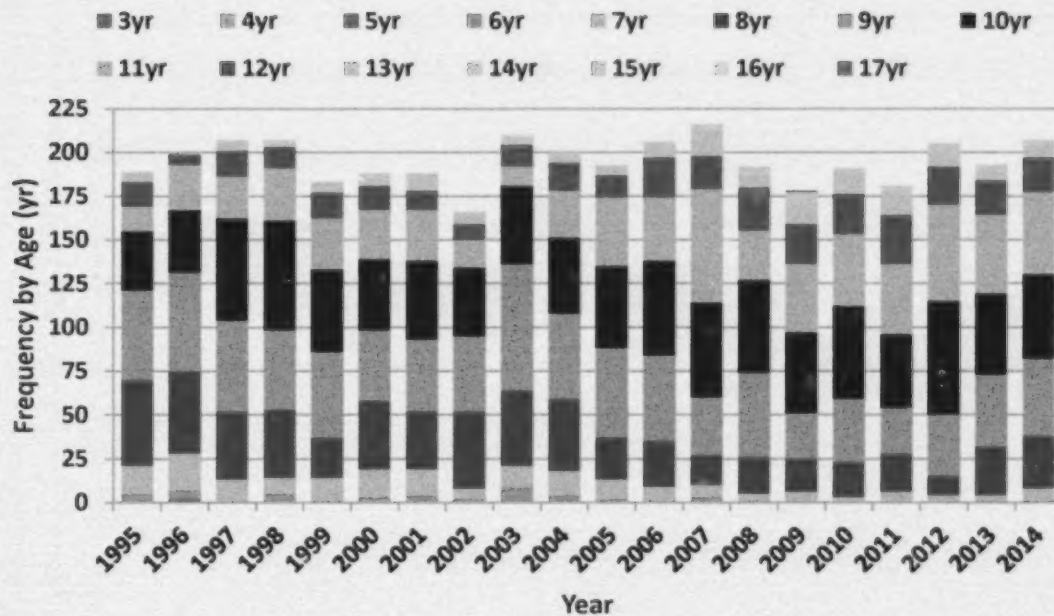


Figure 7: Age-structure of Dall's sheep ram harvest by non-resident and resident hunters in the Mackenzie Mountains, 1995-2014, based upon counting horn annuli.

We calculated an estimated 55.2 lambs per 100 ewes based upon hunter classifications of sheep observed during their hunts in 2014 (Table 8); the average ratio reported since 1995 is 55 lambs:100 ewes (Appendix G). Ground-based surveys were conducted in July in two study areas of the northern Sahtú region of the Mackenzie Mountains on an annual or semi-annual basis from 1997-2014. Average ratios of 62.8 (range 36.7-83.0) and 55.1 (range 17.3-94.1) lambs:100 ewes were reported (A. Veitch unpublished data, Heather Sayine-Crawford personal communication). For the Richardson Mountains of the northern YT and NWT, Nagy and Carey (2013) suggest an August ratio of 43 lambs:100 ewes would have allowed for their observed 10.5% average annual rate of increase from 1986-1991. Subsequent to a decline in this unhunted population from 1997-2003, J. Nagy et al. (unpublished data) reported 28 lambs per 100 'nursery sheep' in August 2003. Surveys in the southwestern YT conducted during late June-mid-July 2015 classified 5,460 sheep, reporting a ratio 37 lambs per 100 nursery sheep; the actual

recruitment in lambs:100 ewes would be higher (Troy Hegel personal communication). Jorgenson (1992) summarized 17 years of lamb:ewe classification data for a population of bighorn sheep in west-central Alberta and found a mean ratio of 43 lambs:100 ewes in September (range 25-54).

Table 8: Observations of Dall's sheep reported by non-resident hunters in the Mackenzie Mountains, 2014.

	Number of Hunters Reporting	Number Observed	Mean Number Observed/hunter	% of Sheep Classified
Rams	218	3,125	14.0	37.4
Ewes ¹	205	3,370	16.0	40.3
Lambs	192	1,860	10.0	22.3

¹ includes females >1-yr-old, yearlings, and younger rams. Also called nursery sheep.

Differences in adult sex ratios among populations may result from differences in hunting pressure, differences in survival of males and females from birth to adulthood, or both (Nichols and Bunnell 1999). However, since the ratio of rams to ewes is almost never equal in wild populations of mountain sheep, even where they are unhunted, it is clear that there is a different natural mortality rate for the two sexes. This difference was believed to be a result of injuries and stress accumulated by males during the breeding season (Geist 1971).

The 93 ram:100 ewe ratio estimated from hunter observations in 2014 is higher than the 88 ram:100 ewe average reported from 1995-2014 (Appendix G). Ground-based surveys were conducted in July in two areas of the northern Sahtú region of the Mackenzie Mountains on an annual or semi-annual basis from 1997-2011. Average ratios of 63.4 and 58.1 rams:100 ewes were reported (A. Veitch unpublished data).

In the YT, mid- to late June annual aerial surveys to count and classify sheep from 1973-1998 reported a mean of 48 rams (range 28-74) per 100 'nursery sheep' (J. Carey

unpublished data). More recently, a similar survey of 5,460 sheep, in late June-mid-July 2015, reported 43 rams per 100 'nursery sheep' (Troy Hegel personal communication). For the unhunted Richardson Mountains herd (YT-NWT), J. Nagy et al. (unpublished data) reported 41 rams per 100 'nursery sheep' in 2003 following a decline from peak population size in 1997. In Alaska, ram:ewe ratio for two unhunted herds in Denali and Gates of the Arctic National Parks typically averaged 60-67:100 (Nichols and Bunnell 1999). In more heavily hunted Alaskan herds, ram:ewe ratio ranged from 33:100 (heavily hunted) to 87:100 (lightly hunted). The ram:ewe ratios reported for the Mackenzie Mountains since 1995 (Appendix G) suggest that the harvest of rams in the Mackenzie Mountains is sustainable at current levels.

More rams were classified by curl in 2014 than since 2008 (Table 9). This may be a reflection of a higher return in observation forms this year. This year, hunters observed fewer legal ($>3/4$ curl) rams ($n=1,372$) than rams with $<3/4$ curl ($n=1,484$). The mean number of legal rams observed per hunt was 7.0 (Table 9). In most years hunters have observed fewer legal rams than rams $<3/4$ curl (Table 9).

Tongue samples from 33 ram sheep were tested for the presence of *Trichinella* spp. An average of 14.8 g (range 5.0-48.7 g) muscle per animal was tested. All samples tested negative for *Trichinella* spp. presence.

From 2010-2013, 59 kidney and ten muscle samples were collected from 59 Dall's sheep. Ages of all the sheep ranged from 7-13 years (mean 9.88). Renal cadmium levels were lower in Dall's sheep than in moose, mountain goat, or caribou. Renal mercury levels in Dall's sheep were lower than in caribou, but higher than in moose or mountain goat. ^{134}Cs was detected in the muscle of two Dall's sheep in 2011, but of no sheep sampled after 2011. This is a clear

marker of deposition from the Fukushima reactor accident of March 2011, which is the only known source of this nuclide.

Recently, ENR Fort Simpson, along with similar departments in other jurisdictions in British Columbia, YT, and Alaska has provided samples of Dall's sheep horn cores for a project looking at landscape genetics across the thornhorn sheep range of northwestern North America. To date 194 individual sheep from the NWT have successfully been genotyped, and the sheep population inhabiting the Mackenzie and Ogilvie Mountains can be further subdivided into four clusters largely delineated by mountain range boundaries and available sheep habitat (Sim et al. 2015).

Table 9: Classification of Dall's sheep rams observed by non-resident hunters in the Mackenzie Mountains, 1995-2014.

Ram Class	2014		2013		2012		2011		2010		2009		2008		2007		2006		2005	
	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl
Number of hunters reporting	208	186	156	149	140	124	149	133	158	142	139	132	184	174	150	168	180	171	186	182
Number of rams classified	1372	1484	1006	1230	1117	987	1234	1168	1314	1620	1040	1093	1520	1698	1902	2266	1769	2019	1787	1899
% of rams classified	48.0	52.0	45.0	55.0	53.0	47.0	51.4	48.6	48.8	55.2	48.8	51.2	47.2	52.8	45.6	54.4	46.7	53.3	48.5	51.5
Mean number of rams observed/hunt	7.0	8.0	6.0	8.0	8.0	8.0	8.0	9.0	8.3	11.4	7.5	8.3	8.3	9.8	11.0	13.5	9.9	12.0	9.6	10.4

Ram Class	2004		2003		2002		2001		2000		1999		1998		1997		1996		1995	
	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl	Horn >¼ curl	Horn <¼ curl
Number of hunters reporting	188	183	127	121	148	133	186	174	151	147	144	138	177	177	205	205	172	174	181	180
Number of rams classified	2185	2324	1662	1654	1720	1720	1812	1765	1351	1717	1579	1756	1848	1924	1538	1586	1713	1699	2070	1645
% of rams classified	48.5	51.5	50.1	49.9	50.0	50.0	50.7	49.3	44.0	56.0	47.3	52.7	49.0	51.0	49.2	50.8	50.2	49.8	55.7	44.3
Mean number of rams observed/hunt	11.6	12.7	11.9	11.9	11.6	12.9	9.7	10.1	8.9	11.7	11.0	12.7	10.4	11.3	7.5	7.7	10.0	9.8	11.4	9.1

Northern Mountain Caribou (*Rangifer tarandus caribou*)

In their 2002 assessment, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the boreal population of woodland caribou as Threatened and the northern mountain population of woodland caribou as Special Concern. These two populations of woodland caribou were subsequently listed under the federal *Species at Risk Act* (SARA) in 2004 and 2007 respectively. Caribou of the Mackenzie Mountains are part of the northern mountain population of woodland caribou. In order to be more specific and to avoid confusion this report will use "northern mountain caribou" when referring to caribou from the Mackenzie Mountains.

Northern mountain caribou are another of the more desired species sought by non-resident hunters. Tags were purchased by 327 (81%) of non-resident hunters (Table 5); the greatest number of tags purchased since reporting started in 1995 (average 259, range 181-327). At least 55% of tag holders hunted caribou, harvesting 179 males. This is higher than the annual average harvest of 160 (range 117-185) from 1991-2014 (Figure 5, Appendix F). The mean ($\pm$ SD) length of a caribou hunt, determined from the 190 reports where hunters spent at least one day hunting, was 4.0 ± 3.0 days (range 1-14 days), comparable to that of previous years (Table 10).

Recently ENR began collecting front incisor teeth from caribou harvested in the southern portion of the Mackenzie Mountains, on a voluntary basis. Teeth are forwarded to Matson's Laboratory for aging. Age is determined by counting the cementum annuli much like the growth rings of a tree. June 1 is used as the birth date for caribou (Matson 1981). The age range from the 32 caribou harvested 2011-2013 is 2-11 years (mean 6.5 years, median 6.3 years; Figure 8).

Table 10: Mean length, SD, and range (in days) of northern mountain caribou hunts where at least one day was spent hunting from 2000-2014.

	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Number Reports	190	196	180	187	175	155	190	172	171	191	120	172	181	178	141
Mean Hunt Length	4.0	3.0	4.0	3.0	4.0	4.0	3.0	4.0	4.3	3.7	4.9	3.8	3.6	4.3	4.0
SD	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.2	3.1	3.8	3.9	2.8	2.7	3.2	2.7
Range	1-14	1-13	1-17	1-16	1-14	1-14	1-15	1-16	1-14	1-32	1-34	1-14	1-12	1-15	1-12

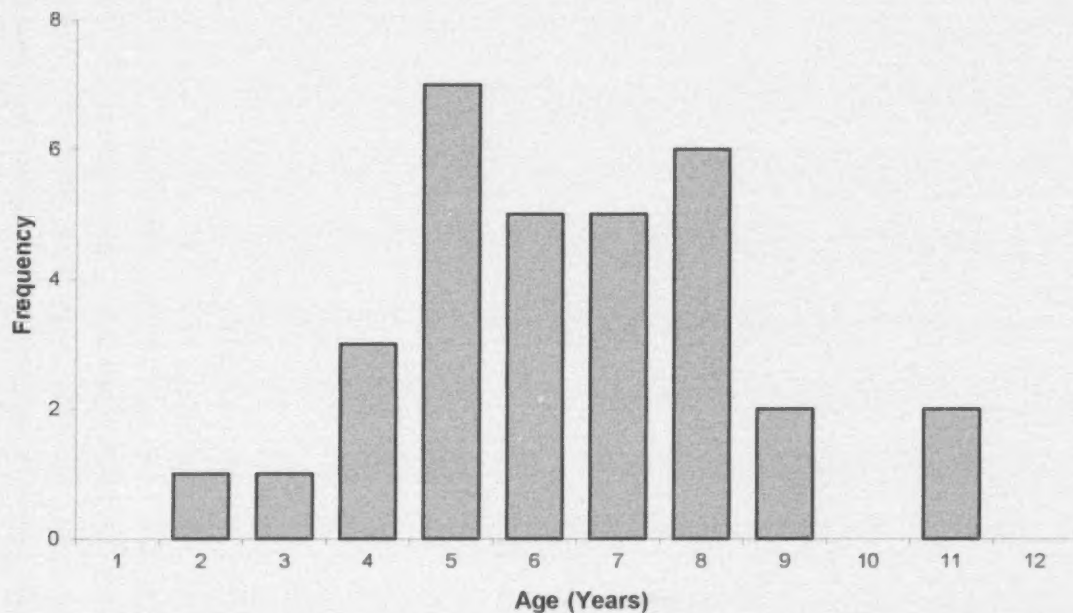


Figure 8: Ages of 32 caribou teeth voluntary provided by southern Mackenzie Mountain outfitters 2011-2013.

We calculated ratios of 36.0 calves and 41.0 bulls (males) per 100 adult females (cows) based upon hunter classifications of northern mountain caribou observed during hunts. Bulls comprised 23.2% of all caribou classified (Table 11). Calf:cow ratios were lower than the average of 43:100 (range 35-59:100) calculated since 1995; conversely bull:cow ratios were higher than the average 38:100 (range 21-61:100) calculated since 1995 (Appendix G).

Table 11: Observations of northern mountain caribou reported by non-resident hunters in the Mackenzie Mountains, 2014.

Sex/Age Class	Number of Hunters Reporting	Number Observed	Mean Number Observed/hunter	% of Total Classified
Bulls	206	4,529	22.0	23.2
Cows	197	11,035	56.0	56.5
Calves	164	3,968	24.2	20.3

Although antler measurement information sometimes goes unreported on outfitter forms, we received antler lengths from 128 (72%) successful hunters. This year, as in other years, there was substantial variation in antler lengths, range 75.0-140.0 cm (29.5-55.1 in.). The maximum left and right antler lengths reported were 137.0 and 140.0 cm respectively (Table 12). The maximum antler length recorded by Boone and Crockett for northern mountain woodland caribou in North America is 158.5 cm (62.4 in.) for a caribou taken from the Mackenzie Mountains in 1978 (Byers and Bettas 1999). Twelve of the top 50 mountain woodland caribou recorded in the 12th edition of the Boone and Crockett Club record book are from the Mackenzie Mountains; the highest scoring antlers hold 8th place (Boone and Crockett Club on-line trophy database accessed 2015). Another measuring system for antlered animals is from Safari Club International (SCI), which has a unique all-inclusive record keeping system for measuring trophies, the most used system in the world. Unlike Boone and Crockett this system has no deductions or penalizing for asymmetry and provides points for all tines which are important for caribou (Jim Lancaster personal communication). Eight of the top 20 mountain woodland caribou recorded in the SCI record book are from the Mackenzie Mountains, with a caribou harvested in 2006 holding second place in scoring (SCI on-line trophy database accessed 2015).

Table 12: Antler measurements of northern mountain caribou bulls harvested by non-resident hunters in the Mackenzie Mountains, 2014. All measurements are in cm (in.).

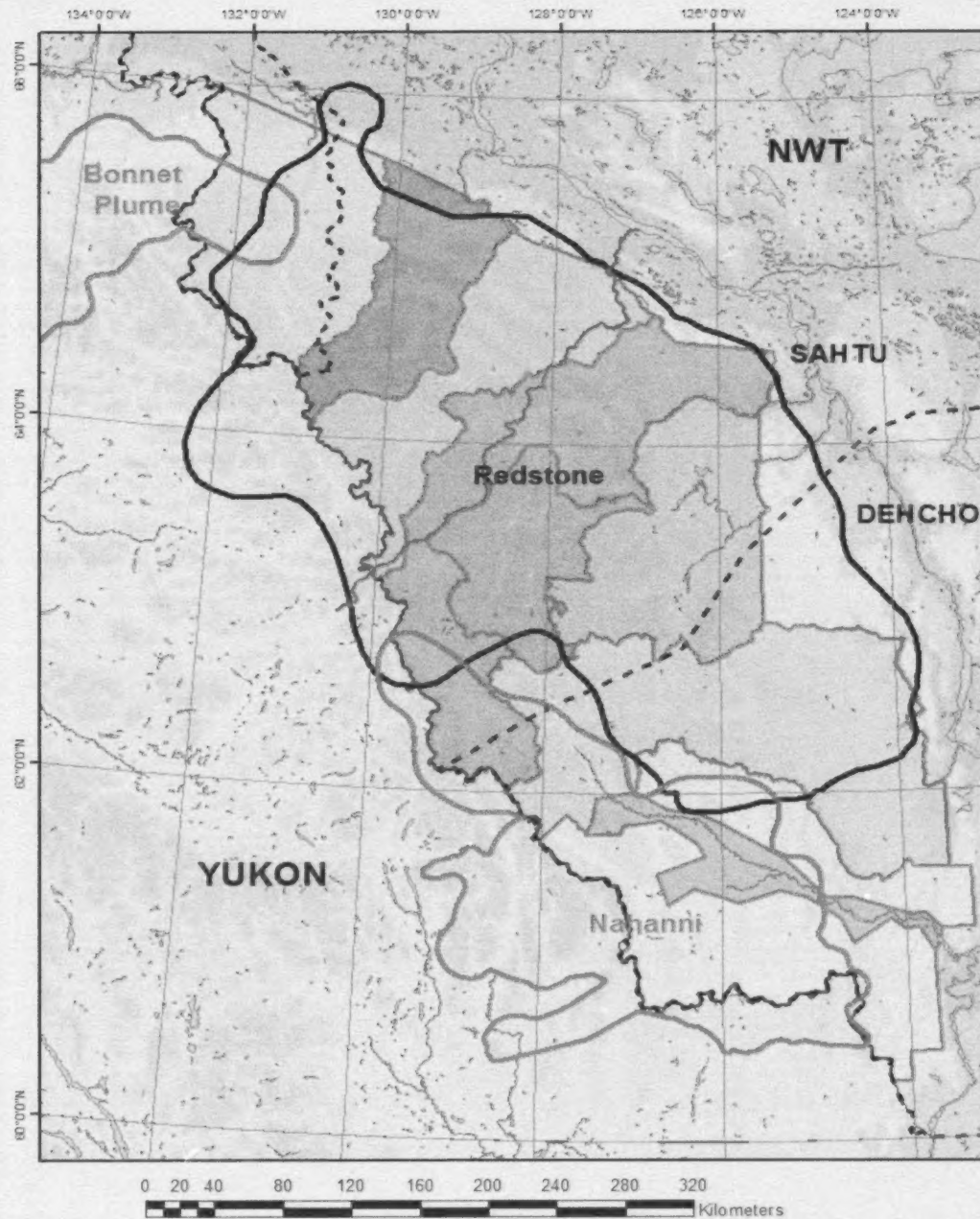
	Contour Length	
	Left Antler	Right Antler
Number Measured	128	128
Mean (cm)	116.1 (45.7 in.)	115.2 (45.4 in.)
SD (cm)	53.6 (21.1 in.)	53.3 (21.0 in.)
Maximum (cm)	137.0 (53.9 in.)	140.0 (55.1 in.)
Minimum (cm)	83.8 (33.0 in.)	75.0 (29.5 in.)

Since 1991 the percentage of bulls observed by clients in the Mackenzie Mountains has never been greater than 28%. This is a lower percentage than the cumulative 39% average adult bull component reported by Bergerud (1978) in his summary of eight North American caribou populations that were either non-hunted or hunted non-selectively (i.e., both males and females included in the harvest). Veitch et al. (2000c) classified 2,659 of an estimated 5,000 caribou in the central Mackenzie Mountains in August 1999 and reported only 25% of those animals as males. Surveys done on the presumed rutting grounds of the South Nahanni caribou population in 1995, 1996, and 1997 reported 24, 28, and 20% of animals classified as males ≥ 1 -year-old (Gullickson and Manseau 2000) and in 2001 reported 27% bulls (Gunn et al. 2002). A 2007 survey during the rut estimated 33.7 bulls:100 adult cows (R. Farnell and K. Egli unpublished data). A 2008 composition count during the rut in the same general area estimated a slightly higher ratio of 35.5 bulls:100 adult cows (Troy Hegel personal communication).

Nagy (2011) determined ten activity periods for northern mountain caribou in the Sahtú using movement data from satellite collared caribou (Olsen 2000, 2001). The breeding period, or rut, was defined as 9-25 October. This period was also the activity period with the greatest daily movement rate (Nagy 2011). Hunter observation data are collected and the 1999 survey was

carried out prior to the breeding period (Veitch et al. 2000c). Surveys conducted well before the rut or breeding period may underestimate the male component of the population. The surveys in 2007 and 2008 were conducted in late September and early October, just prior to the defined breeding period, and findings were more comparable to what Bergerud (1978) reported. Based upon hunter observations there is some evidence that the proportion of males differs between populations, with male:female lower in Redstone than in Bonnet Plume; this difference has been consistent over the past 20 years (Larter 2012a). Further investigation is required to explore demographic attributes of northern mountain caribou in the Mackenzie Mountains.

Northern mountain caribou in the Mackenzie Mountains are estimated to number between 15,000 and 20,000 from at least three separate populations shared between the YT and NWT (Figure 9). Currently, estimated population sizes (excluding calves) are *ca.* 4,200 for the Bonnet Plume, a minimum of 7,300 for the Redstone, and *ca.* 2,700 for the greater Nahanni (South Nahanni, Coal River and Labiche pooled) population (COSEWIC 2014). They are subjected to an annual bull-selective non-resident harvest averaging 160 males per year (1991-2014). The resident harvest of northern mountain caribou in the Mackenzie Mountains also tends to be bull-selective (but not restricted to bulls) and is generally light (*ca.* 30 animals/year); subsistence harvest includes both males and females, with the proportion of each dependent on the time of year that animals are harvested (J. Snortland unpublished data, ENR unpublished data). Subsistence harvesters in the Mackenzie Mountains include residents of both the NWT and YT; harvest is not generally reported.



Scale 1:3,000,000 Projection: Transverse Mercator Datum: NAD 83 THIS IS NOT A LEGAL DOCUMENT

Figure 9: Distribution of Bonnet Plume, Redstone, and greater Nahanni caribou populations following COSEWIC (2014) population polygons. Map: GNWT/B. Fournier, ENR (2013).

Studies on the Redstone herd of northern mountain caribou were initiated in March 2002, with ten female caribou being equipped with satellite radio collars as part of a study of caribou in the central and north-central Mackenzie Mountains initiated by the SRRB (Creighton 2006, Olsen 2000, 2001, Olsen et al. 2001). A recent analysis of these location data indicates that some of the collared animals in the range of the Redstone herd are relatively sedentary year round, while others show the more typical seasonal migratory movements (John Nagy personal communication).

Satellite radio collars were deployed on nine adult female caribou during March 2000 and October 2001 by the YT Department of the Environment (Jan Adamczewski personal communication). These animals were believed to be part of the greater Nahanni population. In October 2004, 18 female caribou were equipped with satellite collars along the YT-NWT border. These caribou were also believed to be from the greater Nahanni population, but three animals were determined to be from the Finlayson population. This was a co-operative study between YT Territorial Government, Parks Canada (NNPR) and the Wildlife Conservation Society (Weaver 2006). In October 2008, 30 female caribou were equipped with satellite collars along the YT-NWT border. Partners in this project include the YT Territorial Government, Parks Canada Agency, ENR, and the Canadian Parks and Wilderness Society, NWT Chapter (Troy Hegel personal communication).

Tongue samples from 34 male mountain caribou were tested for the presence of *Trichinella* spp. An average of 16.2 g (range 5.0-29.3 g) muscle per animal was tested. All samples tested negative for *Trichinella* spp. presence.

From 2010-2011 and 2013, 76 kidney and ten muscle samples were collected from 59 mountain caribou. Ages of 17 of the 26 caribou ranged from 2-8 years (mean 5.91). Renal cadmium levels were higher in caribou than in Dall's sheep and mountain goat, but lower than in moose. Renal mercury levels in caribou were highest in caribou. ^{137}Cs was highest in caribou; ^{134}Cs was not detected in any caribou samples.

Moose (*Alces americanus*)

Tags to hunt moose were purchased by 31% (n=123) of non-resident hunters in 2014; the second greatest number since reporting started in 1991 (Table 5). At least 56% of tag holders hunted moose and harvested 69 bulls. The 2014 harvest was higher than the average 57 moose (range 32-85) harvested annually since 1991, but considerably lower than since 2010 (Figure 10). Since 2005, the number of moose tags purchased has increased (Table 5, Appendix F). Success rates for moose hunts have remained relatively stable, but the increased number of tag sales in recent years has resulted in an increased overall harvest (Figure 10). The mean ($\pm$ SD) length of a moose hunt, determined from the 71 reports where hunters spent at least one day hunting, was 4.0 ± 3.0 days (range 1-14 days), similar to reports from previous years (Table 13).

In 2005 there was a noticeable increase in moose harvest relative to pre-2005 levels. The consistently higher post-2004 harvest levels are likely in part related to the change in ownership of outfitting zone D/OT/01 (Figure 10). This zone is one of the largest, with an abundance of good moose habitat. From 1991-2004 the average harvest was <4 moose/year, with the majority of clients preferring to hunt Dall's sheep. The new owner has a client base which includes many European hunters who are specifically looking for trophy moose for European mounts; also, the new owner hunts in parts of the zone which were previously unhunted. From 2005-2014 the average harvest has been ~20 moose/year from this zone. Moose in the Mackenzie Mountains are

considered to be of the Alaska-YT subspecies, physically the largest subspecies of moose with large males attaining *ca.* 725 kg. (www.adfg.alaska.gov/index.cfm?adfg=moose.main). Recently, the Mackenzie Mountains have emerged as one of the top destinations to have success in taking these large moose (Jim Lancaster personal communication).

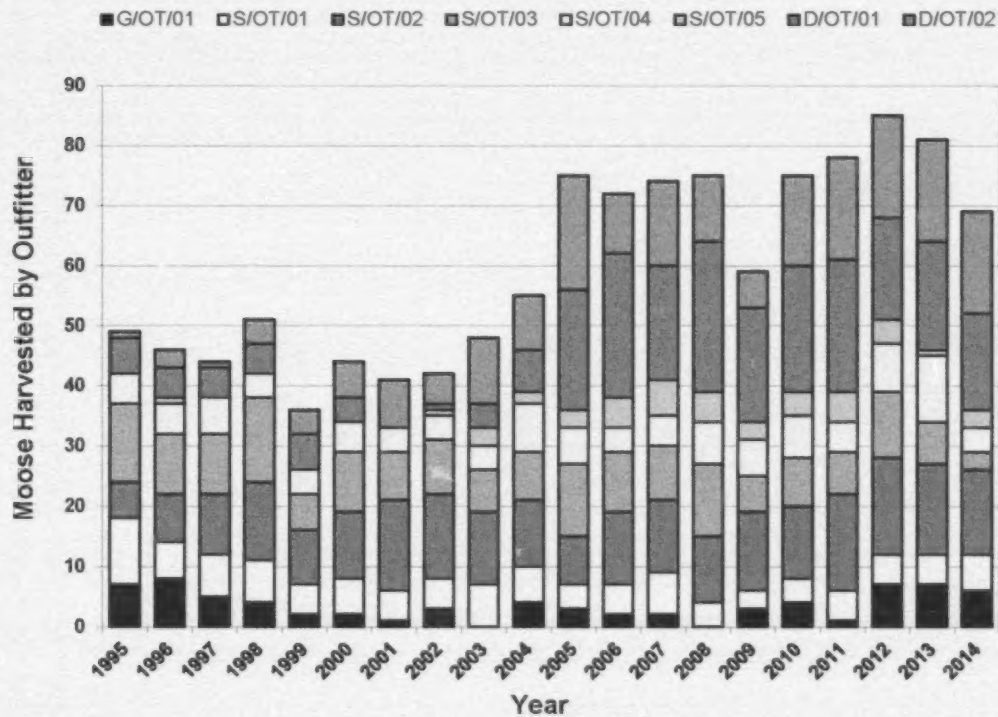


Figure 10: Moose harvested by individual Mackenzie Mountain outfitters from 1995-2014.

Table 13: Mean length, SD, and range (in days) of moose hunts where at least one day was spent hunting from 2000-2014.

		2014	2013	2012	2011	2010	2009	2008	
Number Reports		71	91	85	86	86	68	82	
Mean Hunt Length		4.0	4.1	4.2	4.1	4.5	4.2	3.6	
SD		3.0	3.1	3.1	2.8	4.0	3.4	2.9	
Range		1-14	1-15	1-15	1-14	1-18	1-14	1-16	
		2007	2006	2005	2004	2003	2002	2001	2000
Number Reports	80	72	85	49	60	46	42	48	
Mean Hunt Length	4.0	3.6	4.4	4.8	3.9	3.6	3.7	4.4	
SD	2.5	2.7	3.1	3.3	2.8	2.6	2.9	2.7	
Range	1-9	1-11	1-14	1-12	1-14	1-12	1-12	1-12	

Since 2003 ENR has collected front incisor teeth from moose harvested by hunters in the southern portion of the Mackenzie Mountains on a voluntary basis. Teeth are forwarded to Matson's Laboratory for aging. Age is determined by counting the cementum annuli much like the growth rings of a tree. June 1 is used as the birth date for moose (Matson 1981). We currently have ages from 130 harvested moose; ages range from 3-15 years (mean 7.6 years, median 7.0 years; Figure 11).

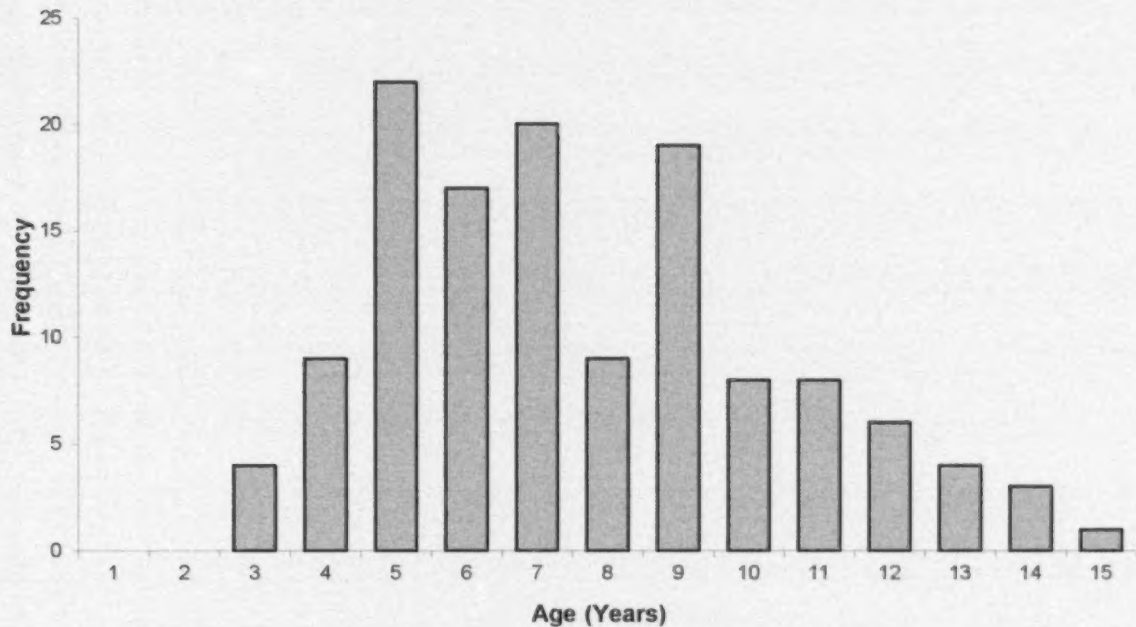


Figure 11: Ages of 130 moose teeth voluntary provided by southern Mackenzie Mountain outfitters from 2003-2014.

The mean ($\pm$ SD) tip-to-tip spread of measured antlers ($n=61$) from bull moose harvested in 2014 was 144.1 ± 49.2 cm (56.7 ± 19.4 in.). We have never received more than 69 antler measurements since records have been kept (Table 14). The maximum recorded antler spread was 184.5 cm (72.6 in.), less than the record spread of 196.9 cm (77.5 in.) for a moose taken in the NWT in 1982. Two moose taken from the Mackenzie Mountains are in the top 25 moose recorded in the record book of the Boone and Crockett Club and currently hold 17th and 24th place respectively. A moose harvested in the NWT Mackenzie Mountains in 2008 was accepted in May 2009 and holds 27th place. A moose harvested during the 2010 season ranks second as a Pope and Young World Record moose with a score of 241 5/8.

Table 14: The yearly mean and range of measured bull moose tip-to-tip antler spread in cm (in.).

	2014	2013	2012	2011	2010	2009	2008	2007
Measured (n)	61	69	67	69	65	53	63	62
Mean Spread	144.1 (56.7)	144.9 (57.1)	142.9 (56.3)	144.0 (56.7)	143.5 (56.5)	143.5 (56.5)	145.5 (57.3)	141.1 (55.6)
Range	89-185 (35.0- 72.6)	97-170 (38.3- 67.0)	98-161 (38.6- 63.4)	113-168 (44.5- 66.1)	106-174 (41.7- 68.5)	92-175 (36.2- 68.9)	101-174 (39.8- 68.5)	102-179 (40.2- 70.5)

	2006	2005	2004	2003	2002	2001	2000	1999
Measured (n)	56	53	38	34	32	32	34	26
Mean Spread	141.3 (55.6)	144.9 (57.0)	150.3 (59.2)	150.0 (59.1)	149.3 (58.8)	144.3 (56.8)	147.0 (57.9)	144.2 (56.8)
Range	107-170 (42.1- 66.9)	122-165 (48.0- 65.0)	127-174 (50.0- 68.5)	107-165 (42.1- 65.0)	103-178 (40.6- 65.0)	113-165 (44.5- 65.0)	127-179 (50.0- 70.5)	109-166 (42.9- 65.4)

Table 5: Observations of moose reported by non-resident hunters in the Mackenzie Mountains, 2014.

Age/Sex Class	Number of Hunters Reporting	Number Observed	Mean Number Observed/Hunter	% of Total Classified
Bulls	43	196	4.6	44.3
Cows	41	190	4.6	43.0
Calves	27	56	2.1	12.7

We calculated ratios of 29.5 calves:100 adult females (cows) and 103.2 bulls:100 cows based upon hunter observations of moose during hunts (Table 15, Appendix G). The calves:100 adult females in 2014 is slightly below the average 30:100 calf:cow ratio recorded since 1995, and virtually identical to that calculated in 2013. The calf:cow ratio reported for the fall remains lower than the 40-60:100 that is generally documented during early to mid-winter aerial surveys for moose along the Mackenzie River in the vicinity of the communities of Fort Good Hope (MacLean 1994a), Norman Wells (Veitch et al. 1996) and Tulit'a (MacLean 1994b) (Appendix G). However, these surveys were conducted after the major fall subsistence harvest and variable

female harvest can certainly impact the interpretation of calf:cow ratios. As no research has been done on moose in the Mackenzie Mountains, we have no explanation for the apparent discrepancy in calf production, survival, or both between the mountains and the river valley. A survey of moose in the Norman Wells study area in January 2001 estimated a calf:cow ratio of 18:100 (ENR Norman Wells unpublished data), and an aerial survey of the Mackenzie River Valley and vicinity in the Dehcho region south from the Blackwater River to Jean Marie River conducted in November 2003 estimated 32:100 (Larter 2009). These studies indicate that low calf:cow ratios may not be restricted to the Mackenzie Mountains and that further studies are required to determine the cause(s). A program was established to document calf:cow ratios annually in November in designated areas of the Mackenzie and Liard River Valleys of the Dehcho through 2010 (Larter 2009). A large-scale aerial survey of the Mackenzie River Valley and vicinity south from the Blackwater River to Jean Marie River, conducted in November 2011, estimated a calf:cow ratio of 54:100 (N. Larter and D. Allaire unpublished data).

The bull:cow ratio of 103.2:100 reported for 2014 is similar to the 104:100 average from 1995-2014 (Appendix G). Bull:cow ratios from the Mackenzie Mountains continue to be generally higher than the range of 27-105:100 reported in the YT (R. Ward cited *in* Schwartz 1997) and 16:100 from heavily harvested populations in Alaska (Schwartz et al. 1992), and average of 46:100 from Norway, range (25-69:100) (Solberg et al. 2002). There has been concern that low bull:cow ratios could influence conception dates, pregnancy rates and newborn sex ratios (Bishop and Rausch 1974, Crête et al. 1981, Solberg et al. 2002) and that management strategies should maintain a high bull:cow ratio (Bubenik 1972).

Studies on tundra moose in Alaska have not found evidence that moose populations with low bull:cow ratios have reduced reproductive rates (Schwartz et al. 1992); populations with a

more skewed sex ratio had a relative rate of population increase greater than populations without a skewed sex ratio (Van Ballenberghe 1983). However, a recent study of eight heavily harvested moose populations in Norway indicated a relationship between declining recruitment rate and skewed adult sex ratio (Solberg et al. 2002). Based upon hunter observations since 1995, there is no indication of any decreasing trend in the bull:cow ratio of moose in the Mackenzie Mountains, hence the adult sex ratios are an unlikely factor in the low calf:cow ratios reported. The reported sex ratios may have an inherent bias towards a greater number of bulls if harvesters consistently spend more time searching for moose in areas frequented more by large males than females.

Tongue samples from 39 male moose were tested for the presence of *Trichinella* spp. An average of 17.0 g (range 10.0-28.9 g) muscle per animal was tested. All samples tested negative for *Trichinella* spp. presence.

From 2010-2013, 32 kidney and 12 muscle samples were collected from 33 moose. Ages of 25 of the 33 moose ranged from 3-14 years (mean 7.04). Renal cadmium levels were highest in moose than in other big game animals, but levels were markedly lower than the mean 222.5 mg/kg ww value used for the consumption advisory (Larter and Kandola 2010). Renal mercury levels in moose were lowest. ^{134}Cs was not detected in any moose samples.

Mountain Goat (*Oreamnos americanus*)

Sales of mountain goat tags show more annual fluctuation than any other ungulate species harvested by non-resident hunters in the Mackenzie Mountains, range 6-58 during 1995-2014 (Table 5) with a mean annual harvest of nine goats (range 1-21) since 1991 (Appendix F). This year, mountain goat tags were purchased by 57 (14%) of non-resident hunters; 14 goats (thirteen males, one female) were harvested. The mean ($\pm$ SD) length of a goat hunt, determined

from the 15 reports where hunters spent at least one day hunting, was 2.0 ± 2.0 days (range 1-8 days), similar to that reported in previous years (Table 16).

Table 16: Mean length, SD, and range (in days) of goat hunts where at least one day was spent hunting from 2000-2014.

	2014	2013	2012	2011	2010	2009	2008
Number Reports	15	13	17	20	13	22	21
Mean Hunt Length	2.0	2.3	2.8	2.3	3.2	2.5	3.0
SD	2.0	1.3	1.7	1.2	1.9	2.0	1.8
Range	1-8	1-5	1-7	1-5	1-7	1-8	1-8

	2007	2006	2005	2004	2003	2002	2001	2000
Number Reports	27	12	18	8	6	4	2	1
Mean Hunt Length	2.7	2.8	3.8	3.9	3.0	2.8	1.5	3.0
SD	1.7	1.5	2.8	1.6	2.6	1.9	0.7	n/a
Range	1-6	2-6	1-14	2-6	1-8	1-5	1-2	3

Mountain goats are known to inhabit five of the eight outfitting zones in the Mackenzie Mountains, occurring almost exclusively below $63^{\circ}00'N$ (Veitch et al. 2002). They are most numerous in high relief terrain along the YT-NWT border between $61^{\circ}00'$ and $62^{\circ}00'N$. However, since 1995 we have received hunter observations or harvest reports of goats from only four of those outfitter zones - D/OT/01, D/OT/02, S/OT/03, and S/OT/04 (Figure 1). In 2014, observations came from two zones, D/OT/01 ($n=35$), and D/OT/02 ($n=242$); harvest occurred in D/OT/01 and D/OT/02. We estimated 67.8 goat kids and 58.5 billies per 100 nannies based upon hunter observations. The kid ratio was higher than the average of 63.3 kids per 100 nannies, but the billy ratio was lower than the 65.4 billies per 100 nannies average from 2002-2014, respectively (Appendix H).

In 2005, we began estimating the age of harvested goats based upon counting horn annuli, and try to age as many harvested goats as possible. The average age of 140 harvested goats (126 billies and 14 nannies) is 7.9 years (range 2.5-16.5). Seventy-nine goats were <8 years old with 61 >8 years old and 34 >10 years old (Figure 12). Three of the 14 goats harvested in 2014 were aged >10 years, with one aged at >16 years old; the oldest recorded goat harvested. The longest horns from a mountain goat taken in 2014 were 23.6 cm (left) and 23.9 cm (right). No mountain goats from the NWT are listed in the 11th edition of the Boone and Crockett Club record book (Byers and Bettas 1999). Based upon age and horn length data over the past nine years there may be a somewhat linear relationship between age and horn length from 5.5-11.5 years, but for ages outside of that range there is almost no relationship, implying that large horned animals are found over a wide range in animal ages (Figure 13).

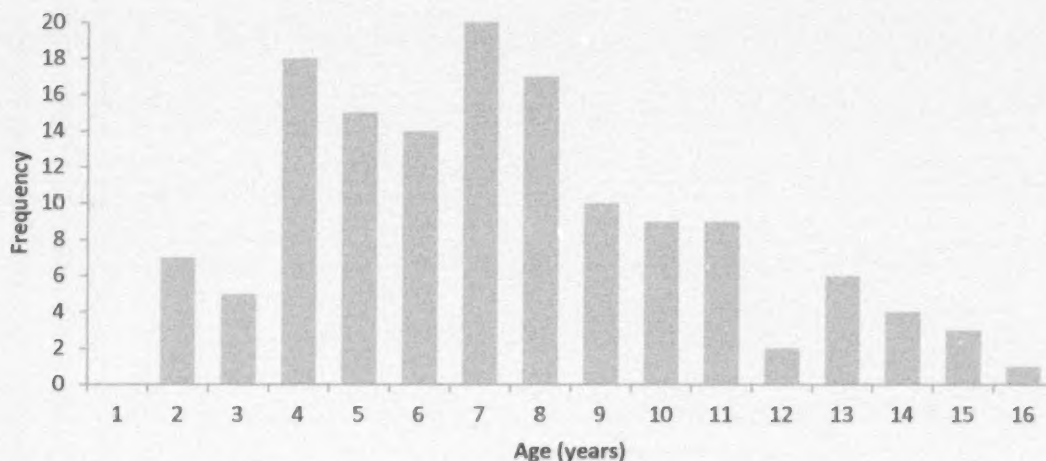


Figure 12: Ages of 140 mountain goats harvested in the southern Mackenzie Mountain based upon counting horn annuli 2005-2014.

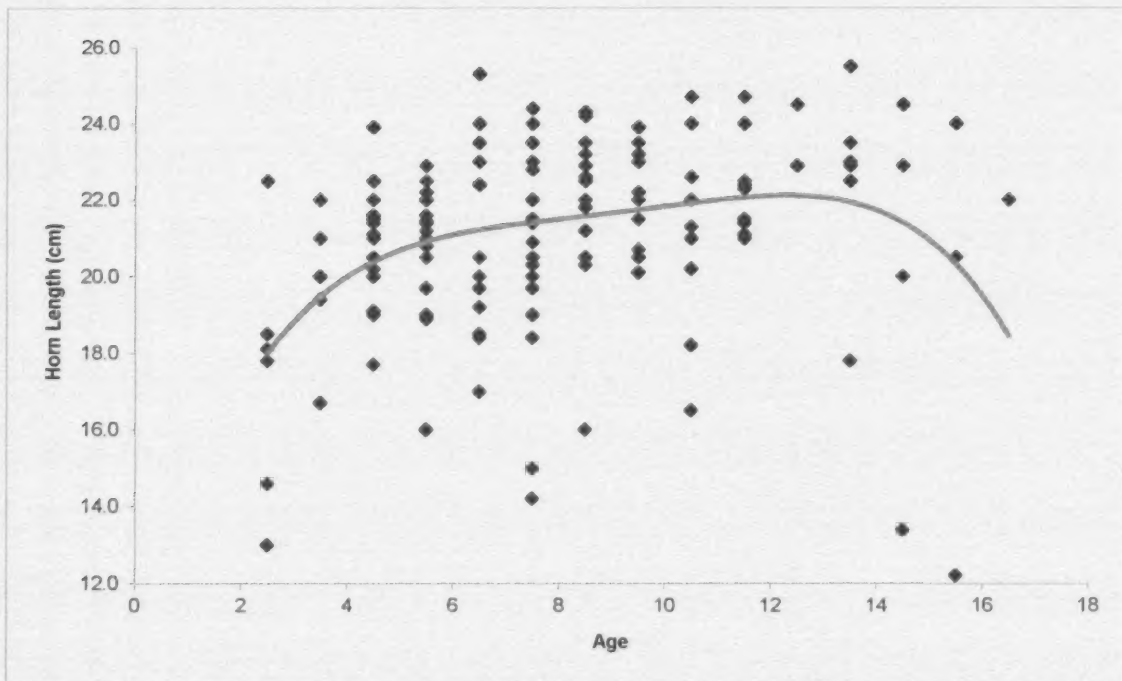


Figure 13: The relationship between the horn length (cm) and age (based upon horn annuli) of 140 mountain goats harvested in the Mackenzie Mountains 2005-2014. Line of best fit is a 4th order polynomial.

There is some evidence that goat numbers and distribution have been increasing in both zones D/OT/01 and D/OT/02 in the southern Mackenzie Mountains (Larter 2004, 2012b, Jim and Clay Lancaster and Werner Aschbacher personal communication). The total number of goats observed has been increasing in recent years and billies have been observed in places they had not been seen previously in these zones (Clay Lancaster and Werner Aschbacher personal communication, Appendix H).

In a 2.5 hr. rotary-winged survey of zone D/OT/02 on 11 September 2006, 88 goats were observed (38 billies, 27 nannies, 19 goat kids, and four yearlings), producing estimates of 140.8 billies and 70.4 goat kids per 100 nannies (N. Larter unpublished data). This survey was conducted in an area that could not be surveyed during a 2004 aerial survey and provided similar numbers of goats and ratio estimates as the 110.7 billies and 71.4 kids per 100 nannies

from that 2004 survey (Larter 2004). A rotary-wing survey was conducted 22-24 August 2011 in the Ragged Range area of zone D/OT/01. 278 goats were observed (124 billies, 80 nannies, 50 goat kids, six yearlings; 18 goats were unclassified), producing estimates of 155.0 billies and 62.5 goat kids per 100 nannies (Larter 2012b). These survey results generally support the contention of increasing goat numbers and distribution but we acknowledge there was seven years between surveys. ENR will continue to work with outfitters in zones D/OT/01 and D/OT/02 to better assess the current status of mountain goats in the Mackenzie Mountains.

The increased harvest of mountain goats since 2004 (Appendix F) may be related to changes in accessibility to the more remote and rugged parts of the various outfitter ranges where goats are resident. The use of rotary aircraft in recent years has permitted outfitters to get into some areas of their zones where they have never been before, areas where goats have been found. This increased accessibility to areas of untouched goat range has likely had some effect on the increased success in goat harvest.

Tongue samples from 15 male mountain goat were tested for the presence of *Trichinella* spp. An average of 12.2 g (range 5.0-28.6 g) muscle per animal was tested. All samples tested negative for *Trichinella* spp. presence.

From 2011-2013, 13 kidney and 11 muscle samples were collected from 16 mountain goats. Ages of all the goats ranged from 3-11 years (mean 6.26). Renal cadmium levels in goats were lower than in moose or caribou, but higher than in Dall's sheep. Renal mercury levels in goats were lower than in caribou or Dall's sheep, but higher than in moose. ^{134}Cs was detected in the muscle of three of four goats sampled in 2011, but of no goats sampled after 2011. This is a

clear marker of deposition from the Fukushima reactor accident of March 2011, which is the only known source of this nuclide.

Wolf (*Canis lupus*)

Wolf tags were purchased by 74% (n=298) of non-resident hunters in 2014 (Table 5). This is similar to what has been purchased yearly since 2009 and represents the second highest number of tags and the third highest proportion of hunters purchasing tags in any year since reporting began in 1995 (Table 17). At least 28% (n=82) of tag holders actively hunted wolves, harvesting 23 wolves (five males, four females and 14 with undocumented gender) (Appendix F). An average of 15 wolves/year has been harvested annually since reporting started in 1991. Hunters reported spending 1-15 days actively hunting wolves (mean $\pm$ SD of 3.7 ± 2.5 days). For the sixth year wolves were hunted during the winter season in zone S/OT/01; two wolves (one male and one female) were harvested in April 2015.

Hunters observed 275 wolves during 2014 which is on the higher end of the 142-317 range from previous years (1995-2013). There is no relationship between the number of wolves observed/year and annual harvest nor does the number of tags purchased/year explain annual differences in wolf observations (Table 17). The number of hunters reporting since 2001 has been consistently higher than in previous years, which is attributed to a change in how we defined hunter reporting. For data collected after 2001, we assumed that all returned observation forms where there was a blank, a zero, or a dash in the box indicating the number of wolves observed was a report of no wolves being observed. When looking at the forms this seemed like a reasonable assumption. This assumption may well be invalid for previous years' data and would bias the post 2001 values to be higher than the previous years.

Table 6: Observations of wolves reported by non-resident hunters in the Mackenzie Mountains, the number of wolves harvested and the number of wolf tags purchased, 1995-2014.

	2014 ¹	2013 ¹	2012 ¹	2011 ¹	2010 ¹	2009 ¹	2008 ¹	2007 ¹	2006 ¹	2005 ¹
# Hunters Reporting	216	242	215	218	203	194	244	244	239	254
# Wolves Observed	275	155	253	184	203	167	260	262	202	245
# Hunters Seeing ≥ 1	42	36	45	74	61	65	76	88	84	76
Number Harvested	23	16	24	21	19	20	17	12	23	19
Number Wolf Tags	298	299	292	285	294	252	228	227	201	204
	2004 ¹	2003 ¹	2002 ¹	2001	2000	1999	1998	1997	1996	1995
# Hunters Reporting	244	203	197	142	116	103	148	141	76	119
# Wolves Observed	317	200	249	215	228	142	148	200	186	269
# Hunters Seeing ≥ 1	81	74	69	65	61	40	57	76	26	26
Number Harvested	18	12	11	15	14	11	9	17	11	14
Number Wolf Tags	166	207	159	137	145	89	165	209	194	72

¹Change in reporting since 2002 may have resulted in the number of hunters reporting for 1995-2001 being artificially low, see text.

Hunters started commenting that they thought wolf numbers were high in 1999. In subsequent years the number of hunters commenting about high wolf numbers increased. This year some of responding hunters indicated that they thought wolf numbers were high.

Tongue samples from 18 wolves (nine males and nine females) were tested for the presence of *Trichinella* spp. An average of 16.7 g (range 5.0-25.2 g) muscle per animal was tested. Sixteen animals tested positive; prevalence was 89%. The mean intensity of infection was 9.5 larva/g (range 0.09-76.84).

Wolverine (*Gulo gulo*)

Over the past nine years about 37% of hunters on average purchase wolverine tags. This year was no exception as tags were purchased by 38% (n=154) of non-resident hunters in 2014. Prior to 2005 there was apparently less interest in purchasing wolverine tags (Tables 5, 18). At

least 16% ($n=24$) of tag holders actively hunted wolverine; one wolverine was harvested this year. Hunters reported spending from 1-15 days actively hunting wolverine (mean $\pm$ SD of 4.2 ± 2.8 days). Although most wolverines were observed in zones S/OT/01 and D/OT/02, wolverines were observed in all eight zones. Not since 1997 have there been observations of wolverines in all zones in one year (Figure. 8). The majority of reported observations were of solitary individuals ($n=22$); there were three observations of groups of two. Historically, wolverine observations have been mostly of solitary animals with few family groups being observed. One could argue that the number of wolverines observed annually from 1995-2014 has somewhat of a cyclical pattern (Table 18, Figure 14). Wolverine numbers are believed to be declining in some other parts of their range in the NWT (SARC 2014); our observations from the Mackenzie Mountains since 1995 do not show a declining trend.

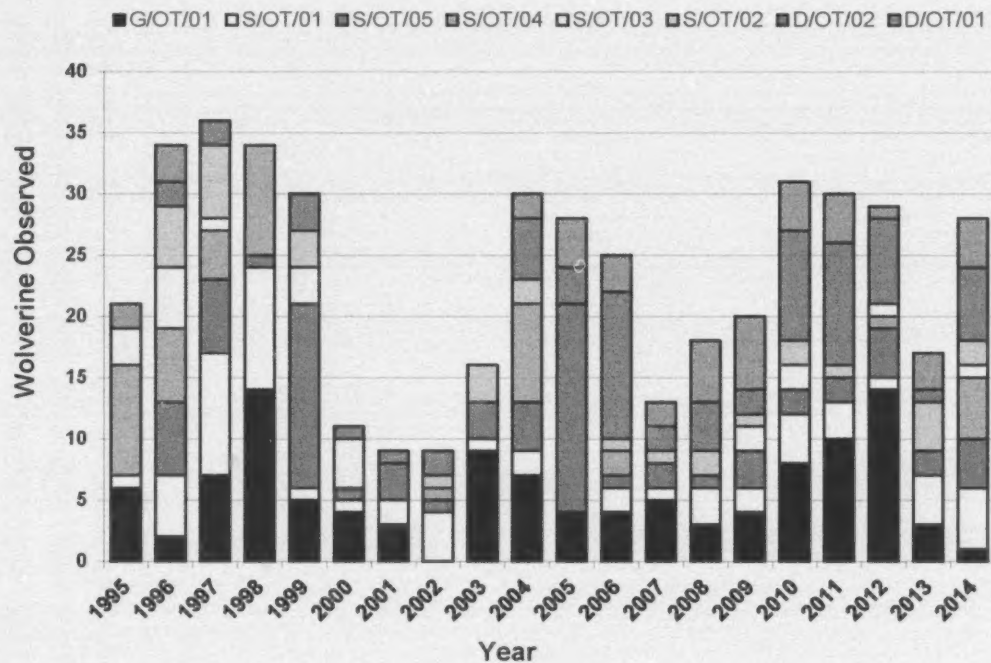


Figure 14: The number of wolverine observed by hunters from 1995-2014 and the outfitter zones where the observations occurred. Data are based upon voluntary hunter observation forms.

There is no relationship between the number of wolverine observed/year and annual harvest nor do the number of tags purchased/year explain annual differences in wolverine observations (Table 18). Wolverines occur throughout the Mackenzie Mountains, but sightings are considered rare. Most wolverine observations are made in hunting zones G/OT/01, S/OT/01, S/OT/05 and D/OT/02.

Table 7: The number of reported observations of wolverine, the number of wolverine harvested, the number of hunters with wolverine tags, the percentage of total hunters with wolverine tags, and the total number of hunting licences purchased for 1995-2014.

Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
Reported Observations	28	17	29	30	31	20	18	13	25	28
Number Harvested	1	2	0	2	3	3	1	0	1	1
No. Wolverine Tags	154	155	153	163	171	133	111	150	108	154
% Wolverine Tags	38	39	39	41	45	39	28	37	27	39
Total Hunting Licences	402	401	396	400	384	339	399	405	407	394
Year	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Reported Observations	30	12	9	9	11	30	34	36	34	21
Number Harvested	0	0	1	2	0	3	0	1	4	1
No. Wolverine Tags	89	141	97	83	78	65	99	135	114	35
% Wolverine Tags	26	40	29	26	23	20	29	38	29	11
Total Hunting Licences	337	347	338	332	332	321	345	352	387	344

Black Bear (*Ursus americanus*)

This year 19 tags were purchased by non-resident hunters for black bears (Table 5); no bears were harvested. Only five black bears have been harvested in the past 24 years. Black bears are relatively rare in the Mackenzie Mountains and when seen are mostly south of 63°00'N. In 2014, 32 black bears (27 adults and five cubs) were reported on returned hunter observation forms (Table 19). This falls in the middle of 17-56 range of observations from 2003-2014 (Table

19). This year bears were observed in four outfitter zones D/OT/01, D/OT/02, S/OT/01, and S/OT/05; some were observed north of 64°00'N. As with the other post-2001 carnivore data, we assumed that all returned observation forms where blanks, zeroes, or dashes occurred in the boxes indicating the number of carnivores observed was a report of no carnivores being observed. This assumption is likely invalid for previous years' data and likely somewhat inflates the post-2001 values relative to 1996-2001 values.

Table 8: Observations of black bears reported by non-resident hunters (including non-hunting guides) in the Mackenzie Mountains, 1995-2014.

	2014 ¹		2013 ¹		2012 ¹		2011 ¹		2010 ¹		2009 ¹		2008 ¹		2007 ¹		2006 ¹		2005 ¹	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad
Total # Observed	5	27	12	18	3	34	2	27	0	29	3	14	8	48	4	34	2	27	4	21
% of Total Observed	16	84	40	60	8	92	7	93	0	100	18	82	14	86	11	89	7	93	16	84
No. Hunters Reporting	262	262	212	212	216	216	218	218	203	203	194	194	244	244	244	244	239	239	256	256
No. Hunters Saw at Least 1	4	22	4	13	1	7	2	19	0	8	3	10	3	10	2	17	1	14	3	18
Maximum # Observed	2	2	4	3	2	3	1	8	0	2	1	3	3	4	2	8	2	11	2	2

	2004 ¹		2003 ¹		2002 ¹		2001		2000		1999		1998		1997		1996		1995 ²	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	All Bears	
Total # Observed	1	23	3	34	3	17	0	7	2	15	4	7	0	15	2	3	1	10	11	
% of Total Observed	4	96	8	92	15	85	0	100	12	88	36	64	0	100	40	60	9	99	nil	
No. Hunters Reporting	229	229	191	191	199	199	127	130	88	93	87	89	121	124	96	96	6	14	44	
No. Hunters Saw at Least 1	1	19	2	21	2	14	1	7	1	10	2	6	0	8	2	3	1	9	9	
Maximum # Observed	1	3	2	7	2	3	0	1	2	3	2	2	0	3	1	1	1	2	2	

¹ Change in reporting for 2002 may have resulted in artificially lower numbers of hunters reporting for 1995-2001.

² All bears not separated out by cubs and adults.

Grizzly Bear (*Ursus arctos*)

The Mackenzie Mountains have been closed to non-residents for hunting grizzly bears since 1982 and resident hunters have been restricted to one bear per lifetime since the same year (Veitch 1999). It is clear from hunter comments on voluntary observation forms that, despite the lack of hunting opportunities, grizzly bears in the Mackenzie Mountains remain a subject of considerable interest for non-resident hunters and their guides (Appendices C, D). For the past 16 years there have been a variety of comments about grizzly bears and 2014 was no exception. This year hunters in 2014 reported the loss of meat, capes and food to grizzly bears, and commented that there were too many grizzly bears and a hunt should be considered. Outfitters also continue to mention camp and equipment damage by grizzly bears both during and after the season. To minimize human-grizzly bear interactions electric fences have been used at main camps, temporary camp use has been reduced, clean camp policy has become standard, and some known high-use grizzly bear areas have been avoided.

Even though moose calf numbers, based upon hunter observations, are generally lower in the Mackenzie Mountains than those reported in the Mackenzie Valley, and predation by grizzly bears could be a potential cause (Ballard 1992), there were few hunter comments indicating low moose or caribou calf numbers.

From 1996-2014, the number of adult grizzly bears observed annually has fluctuated around a mean of 305 (range 218-402), with a slightly positive trend over time; similarly the number of cubs observed annually has a slightly positive trend over time fluctuating around a mean of 77 (range 40-115) (Figure 15, Table 20). This year more adult and cub grizzlies were observed in the Mackenzie Mountains since we began recording observations in 1996.

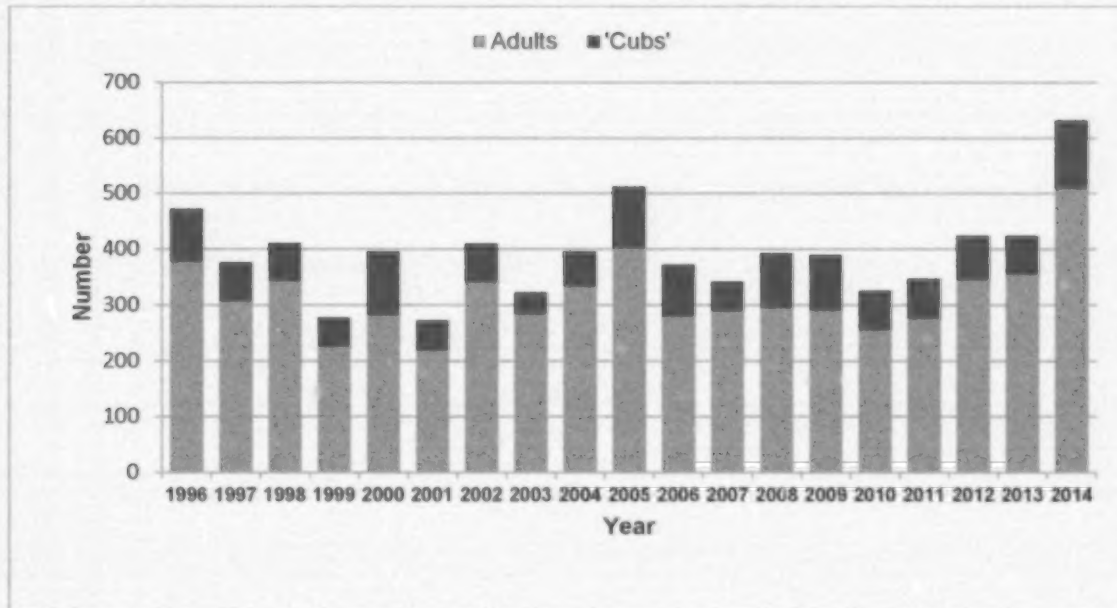


Figure 15: The number of adult and 'cub' grizzly bears observed by hunters from 1996-2014. Data are based upon returned voluntary hunter observation forms. 'Cubs' likely refer to cubs-of-the-year, yearlings, and possibly two-year olds.

In a recent summary of grizzly bear harvest in the Gwich'in Settlement Area, the population for the Mackenzie Mountains zone was 110 bears (≥ 2 years old) (Environment and Natural Resources 2014b). This zone overlaps about 75% of zone G/OT/01 and a small portion of zone S/OT/01 (see Figure 1).

Since 1993 there have been 66 nuisance grizzly bears killed, the majority in the Sahtú ($n=40$), with fewer in the Gwich'in ($n=16$) and Dehcho ($n=10$) regions (ENR unpublished data). The Sahtú covers the largest area of the Mackenzie Mountains at *ca.* 68,000 km². Three nuisance grizzly bear were killed this year, two in the Sahtú region and one in the Gwich'in region of the Mackenzie Mountains.

Most instances of grizzly-human conflict have come at night when grizzlies took the meat, and left without incident. However, two incidents were reported in the southern Mackenzie

Mackenzie Mountains this year where grizzlies claimed either meat or hides from kills while guides were in the vicinity or while they were at camp (Carl Lafferty personal communication). A frequent comment of guided hunters is that bears have lost their fear of humans because of a lack of hunting and they are concerned that this has become a human safety issue. Veitch (1999) reported no documented incidences of injuries to humans caused by grizzly bear attacks. Unfortunately this year a hunter was fatally injured in a grizzly bear attack while he and his guide were butchering a moose. This is the first documented hunter fatality in the Mackenzie Mountains.

Because cub grizzlies in the Mackenzie Mountains tend to stay with their mothers for three years (Miller et al. 1982), reported observations of 'cubs' likely refers to cubs-of-the-year, yearlings, and possibly two-year-old bears. This may account for some of the variability in our cub observations (Figure 15). The percent 'cubs' reported from 1996-2014 ranges from 12.4-29.0 (mean 19.9). Miller et al. (1982) estimated that cubs and yearlings made up 14.3 and 10.4%, respectively of the grizzly population during 1973-1977. If yearlings were reported as cubs this could explain the high range we report for observed 'cubs'.

There have been no demographic studies on grizzly bears in the Mackenzie Mountains since field research conducted in 1973-1977 in a remote area of just 3,000 km² near the YT border (Miller et al. 1982). Miller et al. (1982) documented a low reproductive rate for female grizzly bears. No sows less than eight-years-old produced cubs, the average inter-litter interval was 3.8 years, and there was a mean litter size of 1.8. From 1996-2014 we used voluntary hunter observation forms and estimated litter size from only those observations where cubs were present with a single adult bear. We report a mean litter size of 1.7 based on annual estimates (range 1.3-2.1). Comparisons of our results with Miller et al. (1982) must take into account that we do not

have a large sample size of observations annually and that these observations are potentially from all zones of the Mackenzie Mountains, not a small area. Also, in the 1970s there was non-resident hunting of grizzly bears; non-resident hunting ceased in the Mackenzie Mountains in 1982. Although resident hunting still occurs, it is extremely limited. Therefore grizzly bears observed during 1996-2014 and the current grizzly bear population have really not been exposed to human harvest for a generation.

Table 9: Observations of grizzly bear reported by non-resident hunters in the Mackenzie Mountains, 1995-2014; total number of bears observed, % of cubs/adults, number of hunters reporting grizzly observations, number of hunters seeing at least one cub/adult, the mean and maximum number of cub/adults observed.

	2014		2013		2012		2011		2010		2009		2008		2007		2006		2005	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad
Total # Observed	123	509	69	355	79	345	72	275	71	255	100	290	99	294	54	288	93	279	110	402
% of Total #	19	81	16	84	19	81	21	79	22	78	26	74	25	75	16	84	25	75	21	79
# Hunters reporting	56	155	29	123	46	138	38	123	33	104	47	109	48	139	28	127	50	122	49	150
# Hunters saw ≥ 1	39	103	20	74	24	71	28	65	25	53	36	64	31	64	17	56	32	70	10	65
Mean # Observed	2.2	3.3	2.4	2.9	1.7	2.5	1.9	2.2	2.2	2.5	2.1	2.7	2.1	2.1	1.9	2.3	1.9	2.3	2.0	2.3
Max. # Observed	9	14	6	15	5	14	4	10	5	11	6	20	6	12	5	15	5	12	10	16

	2004		2003		2002		2001		2000		1999		1998		1997		1996		1995	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	All Bears ¹	
Total # Observed	63	333	40	283	69	341	59	222	113	281	52	225	68	343	70	306	96	377	389	
% of Total #	16	84	12	88	17	83	21	79	29	71	19	81	17	83	19	81	20	80	nil	
# Hunters reporting	34	131	19	120	34	128	136	171	108	131	98	117	139	177	110	170	49	132	138	
# Hunters saw ≥ 1	15	57	9	53	11	48	28	104	51	97	28	81	31	105	32	129	46	129	123	
Mean # Observed	1.9	2.5	2.1	2.4	2	2.7	0.4	1.3	1.1	2.1	0.5	1.9	0.5	1.9	0.6	1.8	2.0	2.9	2.8	
Max. # Observed	4	15	12	7	8	20	5	10	8	12	4	12	6	16	12	17	5	15	16	

¹All bears were not separated out by cubs and adults.

ACKNOWLEDGEMENTS

We appreciate the continued co-operation from the Association of Mackenzie Mountain Outfitters and each individual outfitter operation in the Mackenzie Mountains. We thank them for the extra efforts they make in completing, signing, and sending us their harvest reports and meat distribution forms. We especially want to thank those outfitters who spent additional time compiling and sending additional information so that this report could be completed in a timely fashion.

We thank Renewable Resources Officers and clerks with ENR in Norman Wells, Fort Simpson, and Fort Liard for collecting and organizing data from non-resident hunters in their respective offices. We also greatly appreciate the efforts, interest, and co-operation shown by our visiting hunters and the more than 80 guides that completed the forms, reported observations of animals seen, did the various antler and horn measurements, and in some cases provided biological samples. We would particularly like to thank those hunters that took the time to write comments about their hunting experience.

John Nagy provided unpublished data from Richardson Mountain Dall's sheep work and a reanalysis of satellite collared mountain caribou data. We gratefully acknowledge the Boone and Crocket Club for providing us with access to their on-line trophy database and SCI for providing us with caribou data from their on-line trophy database. Matson's Laboratory aged all of the moose and mountain caribou teeth. Brent Wagner, of the Western College of Veterinary Medicine, and Lorry Forbes, of the Canadian Food Inspection Agency, analyzed tongue samples for *Trichinella* spp. Colin Macdonald analyzed the stable metal and radionuclide results.

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LITERATURE CITED

- Ballard, W.B. 1992. Bear Predation on Moose: A Review of Recent North American Studies and Their Management Implications. *Alces* (Supplement) 1:1-15.
- Bergerud, A.T. 1978. Caribou. pp.83-102 in Schmidt, J.L. and D. L. Gilbert (eds.) *Big Game of North America: Ecology and Management*. Stackpole Books, Harrisburg, PA. 494pp.
- Bishop, R.H. and R. A. Raush. 1974. Moose Population Fluctuations in Alaska. 1950-1972. *Le Naturaliste Canadien* 101:559-593.
- Boone and Crockett Club. 2015. Online Trophy Database.
- Bubenik, A.B. 1972. North American Moose Management in Light of European Experiences. *Proceedings of the North American Moose Conference Workshop* 8:276-295.
- Byers, C.R. and G.A. Bettas. 1999. *Records of North American Big Game*. 11th Edition. Boone and Crockett Club, Missoula, MT. 736pp.
- COSEWIC. 2014. COSEWIC Assessment and Status Report on the Caribou *Rangifer tarandus*, Northern Mountain population, Central Mountain Population and Southern Mountain Population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxii + 113 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).
- Creighton, T.B. 2006. Predicting Mountain Woodland Caribou Habitat in the Mackenzie and Selwyn Mountains through Correlation of ARGOS Collar Locations and MODIS Spectral Reflectance. MSc Thesis, School of Geography, Birkbeck College, University of London. 112pp.
- Crête, M., R.J. Taylor and P.J. Jordan. 1981. Optimization of Moose Harvest in Southwestern Quebec. *Journal of Wildlife Management* 45(3): 598-611.
- Environment and Natural Resources, 2014a. Northwest Territories Summary of Hunting Regulations July 1, 2014 to June 30, 2015. Environment and Natural Resources, Government of the Northwest Territories, Yellowknife. 38pp.
- Environment and Natural Resources, 2014b. Summary of Grizzly Bear Harvest Data in the Gwich'in Settlement Area July 2005 to June 2014. Environment and Natural Resources, Government of the Northwest Territories, Inuvik. 7pp.
- Forbes, L.B. and A. Gajadhar. 1999. A Validated Digestion Test with Associated Quality Assurance and Sampling Requirements for use in Pork and Horsemeat. *Journal of Food Protection* 62: 1308-1313.

- Forbes, L.B., D.E. Hill, S. Parker, S.V. Tessaro, H.R. Gamble and A.A. Gajadhar. 2008. Complete Validation of a Unique Digestion Assay to Detect *Trichinella* Larvae in Horsemeat Demonstrates its Reliability for Meeting Food Safety and Trade Requirements. *Journal of Food Protection* 71: 558-563.
- Gamberg, M., M. Palmer and P. Roach. 2005. Temporal and geographic trends in trace element concentrations in moose from Yukon, Canada. *Sci. Total Environ.* 351-352: 530-538.
- Geist, V. 1971. *Mountain Sheep: a Study in Behaviour and Evolution*. University of Chicago Press, Chicago, IL. 399pp.
- Geist, V. 1993. *Wild Sheep Country*. NorthWord Press, Minocqua, WI. 173pp.
- Gullickson, D. and M. Manseau. 2000. South Nahanni Woodland Caribou Herd Seasonal Range Use and Demography. Parks Canada Agency. 87pp.
- Gunn, A., R. Farnell, J. Adamczewski, J. Dragon and L. Labarge. 2002. Census for the South Nahanni Mountain Caribou Herd, September 2001. Resources, Wildlife and Economic Development. Manuscript Report No. 147. 36pp.
- <http://www.adfg.alaska.gov/index.cfm?adfg=moose.main>.
- <http://www.canadianzinc.com/docs/NR060909.001.pdf>.
- <http://www.huntingreport.com>.
- http://www.pc.gc.ca/pn-np/nahanni/ne/ne2_e.asp.
- <http://www.spectacularnwt.com/whattodo/hunting/themackenziemountains>.
- Jorgenson, J.T. 1992. Seasonal Changes in Lamb:Ewe Ratios. *Northern Wild Sheep and Goat Council* 8:219-226.
- Larter, N.C. 2004. Mountain Goat Survey Flat River Area, Western Mackenzie Mountains, September 2004. Resources, Wildlife and Economic Development. Manuscript Report No. 157. 24pp.
- Larter, N.C. 2009. A Program for Monitoring Moose Populations in the Dehcho Region of the Northwest Territories, Canada. *Alces* 49: 89-99.
- Larter, N.C. 2012a. Preliminary Analysis of Hunter Observations of Northern Mountain Caribou in the Mackenzie Mountains, 1991-2010. Environment and Natural Resources. Manuscript Report No. 217. 16pp.
- Larter, N.C. 2012b. Mountain Goat Survey Ragged Range Area, Southern Mackenzie Mountains, August 2011. Environment and Natural Resources. Manuscript Report No. 212. 25pp.

- Larter, N.C. and D.G. Allaire. 2003. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2002. Resources, Wildlife and Economic Development. Manuscript Report No. 152. 50pp.
- Larter, N.C. and D.G. Allaire. 2004. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2003. Resources, Wildlife and Economic Development. Manuscript Report No. 154. 51pp.
- Larter, N.C. and D.G. Allaire. 2005. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2004. Environment and Natural Resources. Manuscript Report No. 165. 51pp.
- Larter, N.C. and D.G. Allaire. 2006. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2005. Environment and Natural Resources. Manuscript Report No. 168. 72pp.
- Larter, N.C. and D.G. Allaire. 2007. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2006. Environment and Natural Resources. Manuscript Report No. 174. 65pp.
- Larter, N.C. and D.G. Allaire. 2008. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2007. Environment and Natural Resources. Manuscript Report No. 180. 77pp.
- Larter, N.C. and D.G. Allaire. 2009. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2008. Environment and Natural Resources. Manuscript Report No. 195. 80pp.
- Larter, N.C. and D.G. Allaire. 2010. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2009. Environment and Natural Resources. Manuscript Report No. 208. 79pp.
- Larter, N.C. and D.G. Allaire. 2011. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2010. Environment and Natural Resources. Manuscript Report No. 211. 83pp.
- Larter, N.C. and D.G. Allaire. 2012. Mackenzie Mountain non-resident and non-resident alien hunter harvest summary 2011. Environment and Natural Resources, Fort Simpson, NWT. Manuscript Report No. 220. 83pp.
- Larter, N.C. and D.G. Allaire. 2013. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2012. Environment and Natural Resources. Manuscript Report No. 234. 93pp.
- Larter, N.C. and D.G. Allaire. 2014. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2013. Environment and Natural Resources. Manuscript Report No. 245. 85pp.

- Larter, N.C. and K. Kandola. 2010. Levels of arsenic, cadmium, lead, mercury, selenium and zinc in various tissues of moose harvested in the Dehcho, Northwest Territories. *Circumpolar Health Suppl.* 7:351-355.
- Larter, N.C. and C.R. Macdonald. 2015. Multi-element, radionuclide and stable isotope analysis of kidney, muscle and *Trichinella* presence in mountain goat (*Oreamnos americanus*) from the south Mackenzie Mountain Region of the NWT. Environment and Natural Resources. Manuscript Report No. 249. 46pp.
- Larter, N.C., L. Forbes, B.T. Elkin and D.G. Allaire. 2011. Prevalence of *Trichinella* spp. in Black Bears, Grizzly Bears and Wolves in the Dehcho Region, Northwest Territories, Canada, Including the First Report of *T. nativa* in a Grizzly Bear from Canada. *Journal of Wildlife Diseases* 47: 745-749.
- Larter, N.C., C.R. Macdonald, B.T. Elkin, X. Wang, N.J. Harms, M. Gamberg, and D.C.G. Muir. Submitted. Cadmium and other elements in tissues from four ungulate species from the Mackenzie Mountain Region of the Northwest Territories, Canada.
- Latour, P. and N. MacLean. 1994. An Analysis of Data Returned by Outfitted Hunters from the Mackenzie Mountains, NWT, 1979-1990. Renewable Resources. File Report No. 110. 52pp.
- MacLean, N. 1994a. Population Size and Composition of Moose in the Tulit'a Area, NWT, November 1993. Renewable Resources. Manuscript Report No. 78. 28pp.
- MacLean, N. 1994b. Population Size and Composition of Moose in the Fort Norman Area, NWT, November 1993. Renewable Resources. Manuscript Report No. 80. 28pp.
- Matson, G.M. 1981. Workbook for Cementum Analysis. Matson's, Milltown, Montana USA. 31pp.
- Microsoft Corporation. 2010. Excel version 14 (computer program). Redmond, WA.
- Miller, S.J., N. Barichello and D. Tait. 1982. The Grizzly Bears of the Mackenzie Mountains, Northwest Territories. N.W.T. Wildlife Service. Completion Report No. 3. 128pp.
- Minitab Inc. 1989. Minitab version 7.2 (computer program). State College, PA: Minitab Inc.
- Nagy, J.A. 2011. Use of Space by Caribou in Northern Canada. PhD thesis, Department of Biological Sciences, University of Alberta. 164pp.
- Nagy, J. and J. Carey. 2013. Dall's Sheep Survey in the Richardson Mountains, 1991. Environment and Natural Resources. 30pp.
- Nichols, L. and F. Bunnell. 1999. Natural History of Thinhorn Sheep. pp. 23-77 in Valdez, R. and Krausman, P.R. (eds.). Mountain Sheep of North America. University of Arizona Press, Tucson, AZ. 353pp.

- Olsen, B. 2000. Fall Distribution and Population Composition of Woodland Caribou in the Central Mackenzie Mountains, October 2000. Sahtú Renewable Resources Board, Tulit'a, NWT. Environment and Natural Resources. Manuscript Report No. 1 (draft). 34pp.
- Olsen, B. 2001. Caribou Studies in the Redstone River Watershed: Research Proposal 2001. Unpublished research proposal submitted to Sahtú Renewable Resources Board, Tulit'a, NWT. 10pp.
- Olsen, B., M. MacDonald and A. Zimmer. 2001. Co-management of Woodland Caribou in the Sahtú Settlement Area: Workshop on Research, Traditional Knowledge, Conservation and Cumulative Impacts. Sahtú Renewable Resources Board, Tulit'a, NWT. Special Publication No. 1. 22pp.
- Safari Club International. 2015. Online trophy database.
- Schwartz, C.C. 1997. Reproduction, Natality, and Growth. pp. 141-171 in Franzmann, A.W. and Schwartz, C.C. (eds.) Ecology and Management of the North American Moose. Smithsonian Institution Press, Washington, DC. 733pp.
- Schwartz, C.C., W.L. Regelin and A.W. Franzmann. 1992. Male Moose Successfully Breed as Yearlings. *Journal of Mammalogy* 63: 334-335.
- Sim, Z., B. Jex, T. Hegel and D. Coltman. 2015. Landscape genetics assessment of the world's thinhorn sheep populations – Year 2 report. Unpublished progress report, University of Alberta.
- Simmons, N.M. 1968. Big Game in the Mackenzie Mountains, Northwest Territories. Proceedings of the Federal-Provincial Wildlife Conference. 32: 35-42.
- Solberg, E.J., A. Loison, T.H. Ringsby, B.E. Sæther and M. Heim. 2002. Biased Adult Sex Ratio can Affect Fecundity in Primiparous Moose *Alces alces*. *Wildlife Biology* 8: 117-128.
- SARC. 2014. Species Status Report for Wolverine (*Gulo gulo*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT. 141pp.
- Van Ballenberghe, V. 1983. The Rate of Increase in Moose Populations. *Alces* 25: 25-30.
- Veitch, A.M. 1999. Status of Grizzly Bears in the Mackenzie Mountains, NWT. Resources, Wildlife and Economic Development. Unpublished report. 28pp.
- Veitch, A.M. and R.A. Popko. 1996. 1995 Mackenzie Mountain Non-resident Hunter Harvest Summary. Renewable Resources. Manuscript Report No. 90. 32pp.
- Veitch, A.M. and R.A. Popko. 1997. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary, 1996. Resources, Wildlife and Economic Development. Manuscript Report No. 97. 48pp.

- Veitch, A.M., R.A. Popko and N. McDonald. 1996. Size, Composition, and Harvest of the Norman Wells Area Moose Population, November 1995. Renewable Resources. Manuscript Report No. 93. 42pp.
- Veitch, A.M. and E.N. Simmons. 1998. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary, 1997. Resources, Wildlife and Economic Development. Manuscript Report No. 106. 38pp.
- Veitch, A.M. and N. Simmons. 1999. Dall's Sheep – Northwest Territories. pp.54-58 *in* Toweill, D.E. and V. Geist (eds.) Return of Royalty: Wild Sheep of North America. Boone and Crockett Club and Foundation for North American Wild Sheep, Missoula, MT. 224pp.
- Veitch, A. and E. Simmons. 2000. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary, 1999. Resources, Wildlife and Economic Development. Manuscript Report No. 121. 38pp.
- Veitch, A.M., E. Simmons, J. Adamczewski and R.A. Popko. 2000a. Status, Harvest, and Co-management of Dall's Sheep in the Mackenzie Mountains, NWT. Northern Wild Sheep and Goat Council 11: 134-153
- Veitch, A., E. Simmons and N. Whiteman. 2000b. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary, 1998. Resources, Wildlife and Economic Development. Manuscript Report No. 120. 40pp.
- Veitch, A., R.A. Popko and N. Whiteman. 2000c. Classification of Woodland Caribou in the Central Mackenzie Mountains, Northwest Territories, August 1999. Resources, Wildlife and Economic Development. Manuscript Report No. 122. 24pp.
- Veitch, A. and E. Simmons. 2002. Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary, 2000. Resources, Wildlife and Economic Development. Manuscript Report No. 137. 40pp.
- Veitch, A, E. Simmons, M. Promislow, D. Tate, M. Swallow and R.A. Popko. 2002. The Status of Mountain Goats in Canada's Northwest Territories. Northern Wild Sheep and Goat Council 13: 49-62.
- Weaver, J.L. 2006. Big Animals and Small Parks: Implications of Wildlife Distribution and Movements for Expansion of Nahanni National Park Reserve. Wildlife Conservation Society Canada, Toronto, ON. Conservation Report No. 1. 108pp.
- Yukon Renewable Resources. 1996. Sheep Management Guidelines. Renewable Resources. Whitehorse, YT. 10pp.

APPENDIX A

Outfitters licenced to provide services to non-resident hunters in the Mackenzie Mountains, NWT – 2014.**D/OT/01 – SOUTH NAHANNI OUTFITTERS LTD.**

Werner and Sunny Aschbacher
 PO Box 31119
 Whitehorse, YT Y1A 5P7
 Ph: (867)-399-3194
 Fx: (780)-665-7076
 e-mail: huntnahanni@gmail.com
 website: www.huntnahanni.com

D/OT/02 – NAHANNI BUTTE OUTFITTERS

Jim Lancaster
 PO Box 3854
 Smithers, BC V0J 2N0
 Ph: (250)-846-5309
 2nd Ph: (250)-263-9197
 e-mail: jladventures@xplomet.com
 website: www.lancasterfamilyhunting.com

G/OT/01 – ARCTIC RED RIVER OUTFITTERS

Tavis Molnar
 PO Box 1
 Whitehorse, YT Y1A 5X9
 Ph: (867)-633-4934
 Fx: (867)-633-4934
 e-mail: info@arcticred-nwt.com
 website: www.arcticred-nwt.com

S/OT/01 – GANA RIVER OUTFITTERS

Harold Grinde
 P.O. Box 528
 Rimbey, AB T0C 2J0
 Ph: (403)-357-8414
 e-mail: ganariver@pentnet.net
 website: www.ganariver.com

S/OT/02-MACKENZIE MOUNTAIN OUTFITTERS

Stan and Helen Stevens
 P.O. Box 175
 Dawson Creek, BC V1G 4G3
 Ph: (250)-786-5118
 Fx: (250)-786-5404
 e-mail: mmostanstevens@gmail.com
 website: www.mmo-stanstevens.com

S/OT/03 – RAM HEAD OUTFITTERS

Stan and Debra Simpson
 P.O. Box 89
 Warburg, AB T0C 2T0
 Ph: (780)-848-7578
 Fx: (780)-848-7550
 e-mail: ramheadoutfitters@hotmail.com
 website: www.ramheadoutfitters.com

S/OT/04 - NWT OUTFITTERS

Clay Lancaster
 PO Box 3854
 Smithers, BC V0J 2N0
 Ph: (778)-210-0262
 e-mail: jladventuresxplomet.com
 website: www.lancasterfamilyhunting.com

S/OT/05 - REDSTONE TROPHY HUNTS

Dave Dutchik
 P.O. Box 1172
 Cochrane, AB T4C 1B2
 Cell: (250)-261-9962
 Ph/Fx: (403)-975-8862
 e-mail: redstonehunts@yahoo.ca
 website: www.redstonehunts.com

APPENDIX B

Summary of fees, bag limits, and seasons for big game species available to non-resident hunters in the Mackenzie Mountains, NWT - 2014. (Note: all prices are in Canadian funds.)

Species	Status	Tag Fee	Trophy Fee	Bag Limit	Season
Black Bear	Non-resident	\$40.00	\$200.00	1 adult bear not accompanied by a cub	15 Aug - 31 Oct
	Non-resident alien	\$100.00	\$200.00		15 Aug - 30 June
Woodland Caribou	Non-resident	\$40.00	\$400.00	1	25 Jul - 31 Oct
	Non-resident alien	\$100.00	\$400.00		
Mountain Goat	Non-resident	\$40.00	\$400.00	1	15 Jul - 31 Oct
	Non-resident alien	\$100.00	\$400.00		
Moose	Non-resident	\$40.00	\$400.00	1	1 Sep - 31 Oct
	Non-resident alien	\$100.00	\$400.00		
Dall's Sheep	Non-resident	\$40.00	\$400.00	1 adult male with min. $\frac{3}{4}$ curl	15 Jul - 31 Oct
	Non-resident alien	\$100.00	\$400.00		
Wolf	Non-resident	\$40.00	\$200.00	1 or 2 ²	25 Jul - 10 Oct
	Non-resident alien	\$100.00	\$200.00	2	1 Aug - 15 Apr
Wolverine	Non-resident	\$40.00	\$200.00	1	25 July - 10 Oct
	Non-resident alien	\$100.00	\$200.00		

Source: Environment and Natural Resources. 2014. Northwest Territories Summary of Hunting Regulations. Yellowknife, NT. 40pp.

² One wolf limit from D/OT/01-02 and G/OT/01, and two wolf limit from S/OT/01-05.

APPENDIX C

Comments provided from non-resident hunters in the Mackenzie Mountains, NWT on voluntary Hunter Wildlife Observation Report forms, 2014. We have not printed actual names of outfitters or their guides (XXX).

Great hunt, great people, great experience.

Very impressing nature, rich wildlife

Outfitter, terrain and quantity of game were all exceptional!

Awesome outfitter. A-class service and care.

I'm very satisfied with my hunt and look forward to come back here next year and bring more hunting friends in the future.

I had an excellent hunt with an excellent guide. Spike camp was comfortable with good food.

Base camp was excellent with great food. Thank you for the adventure!!

Had a great time, XXX was the best guide, very professional, but also enjoyable to spend time with.

Fantastic experience, less moose seen a lot expected; really demanding, real beautiful.

Everyone was very professional and nice and I spend a very good time here.

XXX is awesome and a great guide. Food and service was great. Everyone is very kind.

Excellent, perfect Outfitter.

Hunted together with her dad, XXX

Over all experience was excellent, very well managed & operated. Game numbers & quality were very high. Attribute to management strategy & Provincial regulations. Looking forward to returning in 2015.

Albeit, it was a short hunt. I had a blast. The country was/is breathtaking. It's a shame that it will become a park and no one or very few will get to enjoy it. Ram was thin. Abscessed tooth problem.

I was impressed with the number of sheep I saw.

Small amount of meat taken home.

Canada is a wonderful place to hunt.

I was very impressed with the organization with XXX, very satisfied.

Great hunt, top notch guides & outfitter.

Awesome Outfitters + guide.

Awesome.

Great outfit + wonderful hunt.

I truly love this place.

My brother and I had a great trip.

I believe it is a real shame the park is taking over the flood creek area and closing it to hunting.

No visitors will ever see the area and the resources available to the hunters will be wasted.

Incredible hunt + guides - crying shame this specific area we hunted will become a park - which means even fewer people will ever get to appreciate it!

Beautiful country, lots of sheep, excellent outfitter.

Excellent experience all around. Loved my 2 guides (XXX, XXX)

Great experience, great hunt. 100% recommended.

Everything was excellent.

Great hunt with abundant game available. The outfitter + guide demonstrate excellent knowledge of both species + hunting methods to ensure my successful hunt.

Best time of my life.
 Everything was great!
 Great place, good outfitter.
 Great people and great country!
 Very nice hunt, professional service, excellent.
 Excellent experience, fantastic outfitter.
 Moose wounded, not retrieved.
 XXX was my guide and he did an excellent job!! Made the trip very enjoyable!! XXX and his team do an outstanding job!
 Grizzly bear confronted us at 10-15 yards.
 We also seen moose + wolves while flying in helicopter to and from hunting area. Estimating 5 bulls, 12 cows, 6 calves and 2 wolves. We boned out meat to bring home but left trimmings, ribs and neck meat with outfitter to give to local village people.
 Great operation, enjoyed myself very much.
 Thanks XXX, XXX and the crew for an experience of a lifetime.
 Great hunt, keep the good work!
 Great hunt, great hunter's good times.
 Great hunt, great client!
 Animals looked good shape.
 Best hunt ever!!
 I kept all the meat.
 We took our meat home with us!
 Animals all looked good.
 All animals looked in good shape.
 Great hunt, great hunter, great area!
 Plenty of rain this hunt. Everything look happy + healthy.
 Love the province and the people!
 This hunt by far has been the best hunting experience of my life. My guides XXX and XXX are top notch. Couldn't ask for better. Thanks you for the opportunity to be here. It has been very enjoyable. I would recommend this outfit to anybody.
 Awesome hunt. Great area. Super guides.
 A beautiful place to get the opportunity to hike, view and hunt. Would love to bring my family up here. Really enjoyed the hunt and would assume that I will be back. Your resource is very special. Might be good to harvest a few grizzlies to control their numbers?
 Moose in good condition, old bull. Warm weather to start, caribou were not moving much.
 205" moose 61 1/2 longest spread.
 Archery Dall's sheep hunt.
 Fantastic hunt!! Great Country! I will return again.
 Excellent attention to detail.
 Wolverine claimed most of meat.
 Very organized outfit, pristine country. Lots of animals.
 Great
 An amazing adventure, words cannot describe, a true wilderness experience.
 Excellent outfitter, very well organized and very conscious of the resource. Well trained guides and staff, excellent horses and equipment.
 Lots of bullet damage. Very little useable shoulder meat.

Great country, good hunt.

We had a fantastic time in Mackenzie Mountains with XXX, true wilderness experience, heaps of quality game. Can't wait to come back.

I've hunted for 50 yrs. + this is the best outfitter I've ever hunted with.

Excellent hunt, first class outfitter.

I am taking 25 lbs. of meat home.

took all meat home with me.

Great country, fantastic hunt.

Everybody the guides, cooks helpers were just great people to be around. Fantastic area and hunt.

Big beautiful country, phenomenal experience.

Excellent experience! Absolutely superb outfitter, staff and guides are top notch.

We had a wonderful time and would recommend XXX to anyone. Guide and staff are very safe and client friendly.

Did not harvest, but had good experience!

Great outfitter, wonderful guide. Can't wait to come back!

Thanks.

XXX is the best hunting operation I've ever hunted with over 30 years. Everything they do is professional, well organized & everyone is super friendly. I will recommend them to all my friends.

Great time, great people, great hunt. 1st class operation.

Great.

Great place, perfect.

My first time in the XXX was a great experience because of the outfitters and the staff.

Excellent hunt, great outfitter, plentiful game.

Great area with perfect remoteness and still have access. Would certainly return to hunt again but so many other areas of North America to see I may not make it back.

Very good game conservation and a healthy population. Outfitter very concerned with conservation of species.

Outfitter was excellent. Quality of game great and overall it was a positive experience. I plan on returning to the XXX and to XXX.

Fantastic experience, great base camp and food. The guides were experienced and knowledgeable.

Great outfitter, lots of game. Wonderful experience, will be back.

Nice experience.

This hunt was the best hunt I have ever been on - including Africa. Everything was first class but most of all the people were top notch. One of the 10 best days of my life.

Wonderful experience. My only concern was the number of bears; we saw grizzly bears often; I was nervous enough of my safety regarding bears I kept my gun ready constantly.

Way too many predators here!!

Great time/great people.

Awesome trip - great animals wonderful people.

Very professional 4 great group of people.

Too many bears.

Too many predators.

Excellent time / excellent outfitter / excellent camp + guides! First rate all the way!

XXX, XXX is the best big game outfit in North America. It was the best area with so much

game I can't thank XXX & XXX enough (I loved it)

Great hunt with XXX. Well run show. Lots of quality animals, would love to come back soon.

Beautiful country, along with amazing people that make up XXX.

Had to go home, family emergency.

This trip was exceptional - beautiful country - great animals and wonderful people.

From the moment of getting here off the plane I have received very professional service. The guides gave very good and informed service. It was truly a pleasure hunting with a hunting outfit that knows how to give a hunter an experience of a lifetime.

Great experience - ample game - great trophy, great outfitter.

You need to open it up to Grizzlies, ridiculous amount of bears!

Great experience as always, two great guides, great job XXX. Two great cooks as always.

Awesome hunt!

Great hunt, had tons of fun.

Best outfit hunting experience I could have ever asked for. Excellent outfitter + excellent crew.

Overall fantastic trip, great operation @ XXX.

Very good experience with XXX and all their crew. Great hunting area with lots of game.

We had a great time and the game was plentiful. Great Outfitter.

Great hunt.

Beautiful country, excellent equipment, very professional management + guides.

Great experience. Saw lots of caribou cows and bulls. Lots of grizzly bear. Not a lot of mature rams seen, ram shot had an old wound on back leg.

Regularly observed caribou, did not observe an abundance of mature rams.

Quick trip but enjoyed every minute of it.

Few older rams, plenty of grizzly bears, bear took all of caribou meat.

Excellent hunting and beautiful country! Quality of animals were plentiful. All animals appeared strong and healthy. Harvested animals had good fat cover and were of good size.

Excellent hunting experience. 2 way radios walkie talkies should be allowed just for safety purposes. Everything done here by the book. Game harvested was in excellent condition.

Quantity of sheep was good + quality excellent. Caribou numbers were low from what I expected but migration had not started. Few bulls, mostly cow + calves. bulls harvested in excellent condition.

Excellent overall hunt, lots of sheep, breath-taking scenery, great outfitters + knowledgeable guides, fair weather - truly a trip of a lifetime!

Great concession for sheep, moose + caribou. Lot of game.

Was an excellent hunt. I saw game every day we hunted and was impressed with the outfitters/guides knowledge of the territory and animals. There seemed to be a good number of animals in all areas we visited. They are appeared in good health with a variety of ages.

Numbers were good. Did not observe any abnormalities. Saw Grizzly was too close to camp, also saw bear on hunt.

Beautiful place. Very game rich!

Great country, amazing experiences. Lots of game, too many bears

Seen lots of game had amazing weather and a fun hunt. Caribou are moving a bit slow. Seen a few really old rams. A lot of different wildlife spotted through the trip.

Both the quantity + quality of the sheep + caribou were excellent. We did not get a chance to hunt moose, but the one we did see looked very healthy. The sheep + caribou all range from young to old all in great shape.

Fourteen days in the bush and saw ample sheep, moose, caribou, wolves and a wolverine.

Great experience and would recommend it to anyone! Meat taken by bear on Sept. 6 was phoned into ENR on the 6th in Norman Wells.

My hunting experience was of the best quality and the animals were amazing too.

The Mackenzie Mountains are spectacular. Amount of game animals, plus remoteness combine for a true wilderness hunting experience. The quality + number of animals seen was outstanding. Very health population. I did not observe and unusual behavior of characteristics in any of the animals.

Good numbers, lots of bear contact while hunting moose.

Saw a lot of caribou, but not a lot of mature caribou.

Large quantities of caribou, including several mature bulls. Several grizzly bears. Many immature rams, ewes. Did not harvest mature sheep.

Caribou seen good condition and high population, saw only 1 (mature) grizzly.

Seen many caribou which all looked to be in great shape.

Observed 200 head of caribou, 20 of which were bulls. 10 of those bulls were mature. Hunted primarily south of XXX Lake. All caribou we observed appeared in good condition.

Saw @ 200 caribou - those we took were in great shape. Large bear grizzly well-nourished it appeared. Were mostly in country south of XXX Lake.

Stay hydrated, she's a battle out there. Caribou herds were hit and miss from day to day. Never noticed anything out of the ordinary. Excellent quality of trophy caribou running around the area.

APPENDIX D

A summary of the 2014 voluntary hunter comments broken down into specific topics.

No. of Hunters Reporting	No. of Hunters Mentioning Good Quality Hunts	No. of Hunters Mentioning Abundance /Quality of Animals	No. of Hunters Mentioning Grizzlies	No. of Hunters Mentioning Wolves	No. of Hunters Mentioning Park Expansion	No. of Hunters Mentioning Bad Weather
159	103	48	16	4	3	1

APPENDIX E

Number, age, and horn length measurements of Dall's sheep rams harvested by non-resident hunters in the Mackenzie Mountains, 1967-2014. Number harvested includes 10¹, 2², 6³, 8⁴, 7⁵, 9⁶, 4⁷ and 11⁸ harvested by resident hunters.

Year	Number of Sheep Harvested	Age (Years)		Length of Right Horn	
		Mean	Sample Size	Mean (cm)	Sample Size
1967-1968	223	8.4	Unknown	86.4	168
1969	110	-	-	-	-
1970	94	-	-	-	-
1971	88	-	-	-	-
1972	110	8.5	96	86.2	90
1973	89	8.9	86	84.4	88
1974	93	9.2	85	88.6	91
1975	129	7.6	67	84.6	127
1976	144	7.8	46	88.0	144
1977	132	5.7	69	86.8	132
1978	187	8.5	115	88.9	165
1979	200	8.7	108	90.8	154
1980	188	-	-	90.1	127
1981	183	8.1	101	92.7	157
1982	126	8.7	98	89.7	124
1983	100	9.0	80	90.9	94
1984	102	8.4	98	91.2	99
1985	123	8.1	115	89.7	112
1986	154	8.8	132	88.4	153
1987	148	8.9	148	89.4	148
1988	177	9.8	166	91.7	161
1989	207	9.9	199	90.4	203
1990	219	9.8	200	90.2	218
1991	170	9.7	161	89.1	170

APPENDIX E (CONT.)

Number, age, and horn length measurements of Dall's sheep rams harvested by non-resident hunters in the Mackenzie Mountains, 1967-2014. Number harvested includes 10¹, 2², 6³, 8⁴, 7⁵, 9⁶, 4⁷ and 11⁸ harvested by resident hunters.

Year	Number of Sheep Harvested	Age (Years)		Length of Right Horn	
		Mean	Sample Size	Mean	Sample Size
1992	203	9.7	199	88.0	202
1993	191	9.7	181	87.6	190
1994	199	9.5	191	89.8	196
1995	189	9.6	189	88.9	189
1996	201	9.5	200	88.7	201
1997	210	10.0	206	89.9	203
1998	215	10.0	207	90.0	209
1999	204	10.2	183	88.8	184
2000	194	10.0	188	88.9	188
2001	199	10.1	183	87.7	184
2002	173 ⁶	9.9	166	89.2	166
2003	213 ³	9.7	210	89.8	212
2004	201 ¹	10.0	199	89.3	200
2005	203 ⁷	10.2	196	89.4	199
2006	208 ⁸	10.4	206	88.4	207
2007	216 ³	10.8	216	88.3	216
2008	192 ⁴	10.6	192	88.8	192
2009	179 ⁵	10.9	178	88.2	178
2010	193 ⁶	10.8	191	88.7	192
2011	181 ⁷	10.8	181	90.5	181
2012	207 ⁶	10.9	205	89.9	206
2013	193 ⁴	10.5	193	87.5	193
2014	208 ⁷	10.5	207	88.4	208
Mean 1972-2014	174	9.5	158	89.0	169

APPENDIX F

Outfitted non-resident hunter harvests in the Mackenzie Mountains, 1991-2014.
 Number harvested includes 10¹, 2², 6³, 8⁴, 7⁵, 9⁶, 4⁷ and 11⁸ harvested by resident hunters.

Year	Number of Licences Sold	Number of Animals Harvested						
		Dall's Sheep	Mountain Caribou	Moose	Mountain Goat	Wolf	Wolverine	Black Bear
1991	354	170	179	40	6	14	3	1
1992	364	203	142	32	4	7	0	0
1993	382	191	191	56	9	7	3	0
1994	356	199	164	46	5	15	2	0
1995	344	189	180	49	6	14	1	0
1996	387	201	175	46	4	9	4	0
1997	352	210	168	44	2	17	1	0
1998	345	215	160	52	5	9	0	0
1999	321	204	117	36	1	11	3	0
2000	332	194	127	44	1	14	0	0
2001	332	199	128	41	2	15	2	0
2002	338	173 ⁶	168	42	5	11	1	0
2003	350	213 ³	143	48	6	12	0	0
2004	347	201 ¹	135	55	6	18	0	0
2005	398	203 ⁷	160	75	18	19	1	0
2006	418	208 ⁸	188	72	12	23	1	0
2007	405	216 ³	165	74	21	12	0	0
2008	399	192 ⁴	167	75	21	17	1	2
2009	339	179 ⁵	125	59	20	20	3	1
2010	384	193 ⁶	158	75	13	19	3	0
2011	400	181 ⁷	181	78	20	21	2	1
2012	405	207 ⁶	168	85	12	24	0	0
2013	409	193 ⁴	182	81	11	16	2	0
2014	407	208 ⁷	179	69	14	23	1	0
Mean 1991-2014	370	198	160	57	9	15	1	0

APPENDIX G

Summary of age and sex ratios calculated from non-resident hunter observation reports in the Mackenzie Mountains, 1995-2014.

Year	Dall's Sheep		Mountain Caribou		Moose	
	Lambs: 100 Ewes	Rams: 100 Ewes	Calves: 100 Cows	Bulls: 100 Cows	Calves: 100 Cows	Bulls: 100 Cows
1995	67	82	36	34	30	95
1996	44	82	45	40	26	76
1997	57	55	36	21	30	107
1998	60	84	35	34	30	95
1999	58	90	43	25	20	100
2000	47	90	41	39	26	89
2001	59	89	56	61	28	120
2002	58	89	59	31	29	96
2003	50	83	39	36	25	129
2004	53	93	42	38	30	101
2005	51	98	42	42	33	110
2006	53	96	43	37	33	137
2007	64	83	52	37	36	101
2008	49	98	41	40	31	115
2009	55	94	45	39	31	90
2010	49	93	45	46	35	101
2011	56	91	44	35	33	123
2012	53	86	40	46	33	88
2013	52	92	36	43	29	106
2014	55	93	36	41	29	103
Mean 1995-2014	55	88	43	38	30	104

APPENDIX H

Summary of age and sex ratios calculated from non-resident hunter observation reports of mountain goats, 2002-2014.

Year	Kids:100 Nannies	Billies:100 Nannies	Total Animals
2002	55.2	75.9	69
2003	61.5	70.5	182
2004	57.1	77.1	84
2005	66.0	50.4	306
2006	61.5	51.4	245
2007	71.2	57.7	393
2008	54.3	97.1	264
2009	64.6	59.0	327
2010	78.3	46.2	239
2011	64.0	59.0	243
2012	51.8	71.9	257
2013	69.6	75.0	144
2014	67.8	58.5	277
Mean	63.3	65.4	233.1